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A NEW SPECIES OF *GERANIUM* (GERANIACEAE) FROM OAXACA, MEXICO

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ABSTRACT

A new species of *Geranium*, ***G. miahuatlanum*** B.L. Turner, is described and illustrated from Mpio. Miahuatlán, Oaxaca, México. It belongs to the series *Repentia* where it relates closely to *G. repens*, a species of Central America, occurring from Guatemala to Panamá.

KEY WORDS: Geraniaceae, *Geranium*, México, Oaxaca

Geranium is a difficult genus, especially in México where numerous, closely related, taxa are recognized. Moore (1943) provided the last definitive treatment of the genus for México, in which 40 or more species were recognized, distributing these among twelve weakly defined series. The present novelty belongs to his series *Repentia* where it relates most closely to *G. repens* H. Moore.

GERANIUM MIAHUATLANUM B.L. Turner, *spec. nov.* Figure 1. TYPE: MEXICO. Oaxaca: Mpio. Miahuatlán, San Agustín, 2735 m, swamp in pine forest, forming colonies, 5 Aug 1996, *Hinton et al. 26744* (HOLOTYPE: TEX!).

Similis *G. repenti* H. Moore sed foliis majoribus, lobis mediis plerumque 2.5-3.5 cm longis (vice 1.8-2.3 cm longis); pedicellis longioribus, plerumque 2.0-3.5 cm longis (vice plerumque 0.5-2.5 cm longis); et calycibus majoribus, tubis 6-7 mm longis (vice 5-6 mm longis).

Repent herbs 0.3-0.6 m high. Stems moderately pubescent with spreading, glandular or eglandular hairs to 1.2 mm long; internodes elongate 2-5 times longer than the midstem leaves. Midstem leaves deeply 3(-5)-cleft, the midlobes 2.5-3.5 cm long, somewhat longer than the lateral lobes. Peduncles mostly 3-6 cm long, 2-flowered, glandular-pubescent. Sepals 7-9 mm long, the bodies 6-8 mm long, glandular-pubescent, 3-nervate. Petals 12-13 mm long, pink to dark pink, glabrous except for the ciliate claw. Capsules ca. 2.5 cm long, the beaks ca. 3 mm long.

ADDITIONAL SPECIMENS EXAMINED: MEXICO. Oaxaca: Mpio. Miahuatlán, Neverias, 2650 m, 1 Jun 1996, *Hinton et al. 26552* (TEX); San Agustín, 2750 m, 5 Aug 1996, *Hinton et al. 26759* (TEX).

The elongate internodes, larger leaves with more linear-lanceolate lobes, longer pedicels and more deeply pink petals readily distinguish this species from its most closely related cohort, *Geranium repens*. The latter, so far as known, is confined to the montane regions of Central America from Guatemala to Panamá, although Moore (1943) cited a single specimen from Guerrero, México, which I take to be a misidentification of *G. hintonii* H. Moore (discussed below).

The series *Repentia*, as treated by Moore (1943) contains three species: a widespread *Geranium repens*; *G. clarum* Small, from Oaxaca, known only from type material; and *G. hintonii*, from Guerrero, known only from type material. The following key will distinguish among the four taxa which make up the series *Repentia*, as recognized here.

KEY TO MEXICAN TAXA OF SERIES *REPENTIA*

1. Pedicels eglandular-pilose; petals white to pale pink.
   2. Pedicels 5-10 mm long; northcentral Oaxaca .... *G. clarum*
   2. Pedicels 12-30 mm long; central Guerrero .... *G. hintonii*
1. Pedicels glandular-pilose; petals pink to dark pink.
   3. Middle lobe of mid-stem leaves 2.5-3.6 cm long; pedicels mostly 25-35 mm long; body of calyx 6-8 mm long; Oaxaca .... *G. miahuatlanum*
   3. Middle lobe of mid-stem leaves 1.8-2.2 cm long; pedicels mostly 20-25 mm long; body of calyx 5-6 mm long; Guatemala to Costa Rica .... *G. repens*

As noted in the above, Moore included in his concept of *Geranium repens* a questionable plant from Guerrero, México, "*Hinton 14579*" which he commented upon, as follows: "The northern representative, *Hinton 14579*, from Guerrero, has villous pubescence and large petals but is so similar in other respects that I am placing it here at present."

Actually the collection number concerned, in my opinion, should be *Hinton 14759*, as shown by two collections at LL!, TEX! and as can be vouched for in Hinton & Rzedowski (1975). Regardless, *Hinton 14759*, in all its characters, clearly belongs to *Geranium hintonii*. Indeed, the plant itself was collected fairly near the type locality of the latter.

ACKNOWLEDGMENTS

I am grateful to Gayle Turner for the Latin diagnosis, and to her and Ted Delevoryas for reviewing the manuscript. Maria Thompson provided the illustration.

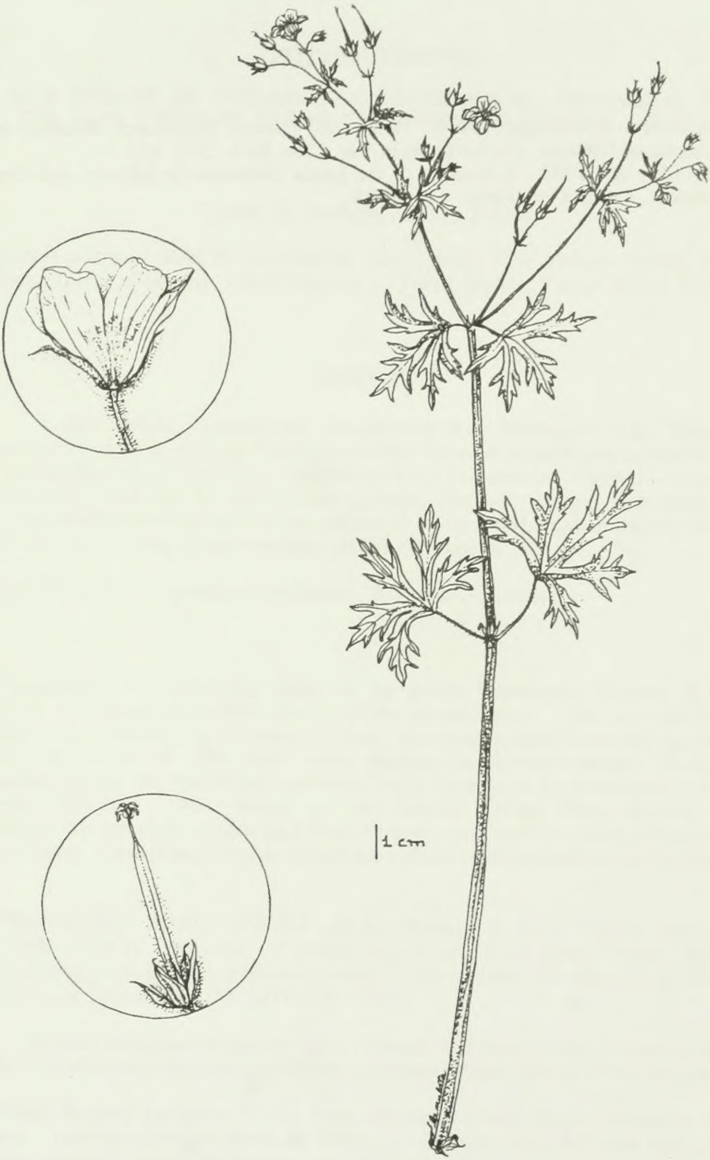

Figure 1. *Geranium miahuatlanum* (from holotype).

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Phytologia (July 1996) 81(1):5-9.

A NEW SPECIES OF *TETRANEURIS* (ASTERACEAE, HELENIEAE) FROM THE LATE TERTIARY VERDE FORMATION OF CENTRAL ARIZONA

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ABSTRACT

A new species, ***Tetraneuris verdiensis*** R.A. Denham & B.L. Turner, is described from Yavapai County, Arizona where it is restricted to lacustrine marl in the Verde Formation. It is related to the *Tetraneuris* "*scaposa -- acaulis* complex," and can be readily distinguished from the closely sympatric *T. scaposa* (*Hymenoxys acaulis* var. *arizonica*) by its dwarf habit, relatively short broad leaves, long-pilose vestiture, and rayless heads.

KEY WORDS: Asteraceae, Helenieae, *Tetraneuris*, Arizona

Preparation of a systematic study of the genus *Tetraneuris* (Bierner & Turner 1997) by the junior author has occasioned the present paper. This new species was brought to his attention by the senior author, who first became aware of its existence during the winter of 1993-1994 while engaged in floristic studies of localized substrates within the lacustrine limestone Verde Formation in northeastern Yavapai County, Arizona. Jean Searle of the Arizona Native Plant Society, while accompanying the senior author on a field trip to the type location, first pointed out the uniqueness of these populations as compared to *Tetraneuris* elsewhere in Arizona.

TETRANEURIS VERDIENSIS R.A. Denham & B.L. Turner, *spec. nov.* TYPE: U.S.A. Arizona: Yavapai Co., 5 mi. E of Camp Verde, 3300 ft., occurring on marl with gypsum crystals at the surface, 14 May 1995, *Denham, Fobes, & Searle 1840* (HOLOTYPE: TEX).

Similis *Tetraneuri scaposae* (DC.) Greene sed planta nana et eradiata est, 4-7 cm alta, indumentum candudum -- pilosum habens, pilis 3-7 mm longus.

Dwarf scapose perennial 4-7 cm high, the stems arising from a branched woody caudex. Leaves relatively thick, all basal, 1.5-2.5 cm long, 3-5 mm wide; blades ovate to narrowly ovate, moderately but deeply glandular-punctate, entire, markedly

white-pilose throughout with hairs 3-6 mm long, the apices acute to obtuse. Scapes 4-6 cm long, ebracteate, pilose with upwardly appressed and widely spreading hairs 1-4 mm long. Heads single, hemispheric. Involucres 5-6 mm high, 3-4 mm across. Ray florets absent. Disk florets ca. 40 (est.); corollas yellow, ca. 3.5 mm long, the tube ca. 0.5 mm long, the lobes 5, densely pubescent. Anthers yellow with ovate appendages. Style branches truncate, apically hispidulous. Achenes (immature) ca. 3 mm long, densely pubescent; pappus of ca. 8 lanceolate scales 2-3 mm long.

Additional collections: *Denham, Fobes, & Searle 1835, 1836, 1837, 1838*, and *1839*, all from the same location as the type, from either the same population as the type or from an adjacent population on a nearby hilltop.

GEOLOGY AND FLORISTICS OF THE TYPE LOCATION

Tetraneuris verdiensis can best be understood with a perspective on the geology and floristic patterns of the type location and surrounding areas within the Verde Formation. During the late Tertiary Period, the Verde Formation and other lacustrine deposits formed in a series of basins across the sub-Mogollon region of Arizona. These basins are home to a number of endemics which are often restricted to particular substrates. In addition to these endemics, disjunct occurrences of several other species are found in these lacustrine deposits (Anderson 1996).

The Verde Formation in northeastern Yavapai County was formed primarily through deposition and precipitation within a shallow lake bed created by down-dropping along the Verde Fault and subsequent blockage of the drainage outlet by volcanic and/or tectonic activity. The upper part of the formation, exposed at the northwestern end of the Verde Valley near Cottonwood, Arizona, is comprised of narrow interbedded layers of limestones, mudstones, and marls. The lower part of the formation, exposed at the southeastern end of the valley near Camp Verde, Arizona, is comprised mostly of more massive limestones formed in the deepest parts of the lake and evaporites, such as salt deposits and gypsum. Near the lower end of the valley are volcanoclastic deposits adjacent to and of approximately the same age as the lacustrine deposits.

Major changes in the floristic communities occur along with changes in substrate within the Verde Formation. The xeric hillside habitats on the interbedded layers near the upper end of the valley are dominated by *Canotia holacantha* and *Juniperus coahuilensis* (Martinez) Gaussen *ex* R.P. Adams. On the massive limestones in the lower valley, the flora includes some species more typical of higher elevations, such as *Juniperus osteosperma* (Torrey) Little, *Purshia stansburiana* (Torrey) Henrickson, and *Ipomopsis aggregata* (Pursh) V. Grant. The adjacent volcanic tuff supports a community with a Sonoran component, including *Agave chrysantha* Peebles, *Opuntia acanthacarpa* Engelm. & Bigelow var. *thornberi* (Thornber & Bonker) L. Benson, and *Acacia constricta* Benth.

Several taxa endemic to the late Tertiary sub-Mogollon lacustrine basins are found to occur along particular soil horizons. In the Verde Valley, *Purshia subintegra*

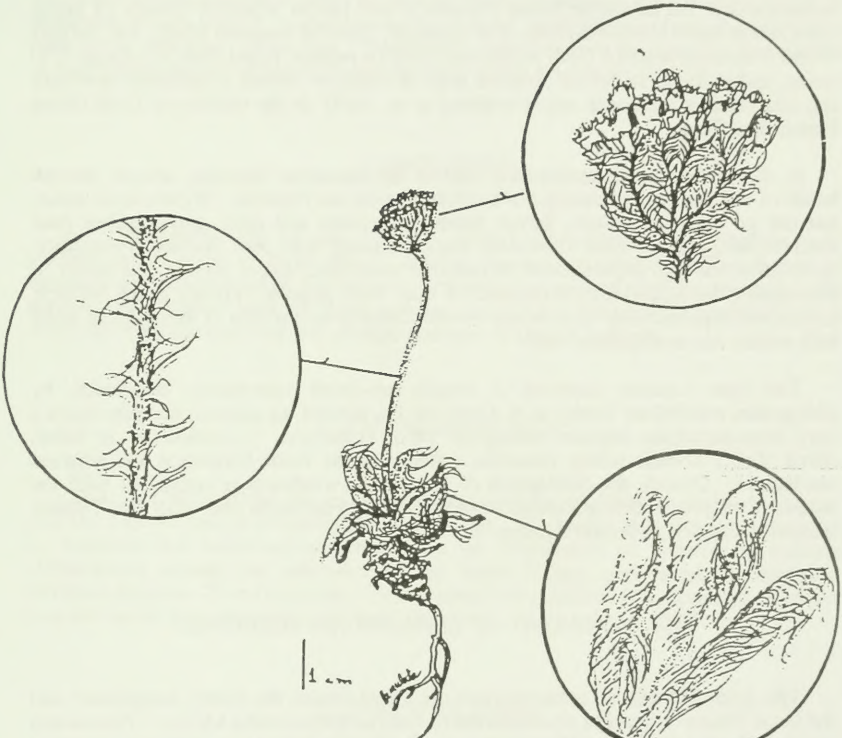

Figure 1. *Tetraneuris verdiensis* R.A. Denham & B.L. Turner, from holotype. The enlarged circle at lower right depicts several folded leaves.

(Kearney) Henrickson only occurs near the upper end of the Verde Formation and then only where there are clastic elements derived from the Mesozoic sandstones of the Supai Group, and *Eriogonum apachense* is restricted to a horizon at ca. 3500' in the block-forming limestones of the lower valley. Many other species with disjunct occurrences in the lacustrine Verde Formation also follow a similar pattern of being restricted to specific soil horizons. For example, *Quercus havardii* Rydb. var. *tuckeri* Welsh from southeastern Utah is disjunct from its nearest population by almost 170 miles, and is found in central Arizona only at locations where a particular powdery clay-like calcium carbonate soil is exposed at ca. 3400' in the vicinity of Dead Horse Ranch State Park.

In the lowest, southeastern-most end of the lacustrine deposits, several narrow bands of different soils running northeast-southwest are exposed. Within three miles, one can go from limestones, across bands of gypsum and marl, and continue onto volcanic tuff, each of these substrates accommodating their own floristic community. In this area, the type population of *Tetraneuris verdiensis* occurs on one of a series of low chalky flat-topped hills composed of marl with gypsum crystals at the surface. Additional populations of *Tetraneuris verdiensis* occur on the tops of the adjacent small hills within this stratigraphic unit.

The type location supports a dwarf sub-shrub community dominated by *Eriogonum ericifolium* Torrey & A. Gray var. *ericifolium*, an edaphic endemic known only from lacustrine deposits within the Verde Formation. Co-dominant is *Salvia dorrii* (Kell.) Abrams subsp. *mearnsii*, endemic to the Verde Formation and adjacent sandstones. Overall, the distribution of *Tetraneuris verdiensis* is consistent with the pattern of edaphic endemism found within the Verde Formation and other late Tertiary lacustrine deposits in central Arizona.

THE TAXONOMY OF *TETRANEURIS VERDIENSIS*

The genus *Tetraneuris* is known from the Great Basin, the Rocky Mountains, and the Great Plains. It reaches its southwestern limit in north-central México. *Tetraneuris scaposa* Greene (including *Hymenoxys acaulis* (Pursh) Parker var. *arizonica* [Greene] Parker) is common in the northern parts of Arizona. This taxon also has a disjunct range to the south in the lacustrine limestone Verde Formation and adjacent Mesozoic sandstones in Yavapai County (Anderson 1996 *ibid.*). In the Verde Valley, *T. scaposa* has been collected by the senior author at Cottonwood, Arizona near the upper end of the valley. Anderson (1996 and pers. comm.) has collected this same taxon along Middle Verde Rd., west of Camp Verde, Arizona. This latter site is approximately seven miles from the type location of *T. verdiensis*. Although both of these species occur in the Verde Valley, there is no evidence of intergradation, no intermediate forms, and no individuals exhibiting a recombination of characteristics between these two species.

One important characteristic of *Tetraneuris verdiensis* is its discoid heads. Discoid individuals are known elsewhere in *Tetraneuris*, as isolated individuals within populations of *T. acaulis* Greene (*Hymenoxys acaulis* var. *acaulis*) in Wyoming.

These individuals, which have formed the basis for *T. eradiata* A. Nelson, differ from their neighbors only in their discoid condition, and are currently considered to be aberrant forms of *T. acaulis*. The situation in the Verde Valley is radically different. Here *T. scaposa* and *T. verdiensis* can be distinguished by a suite of characteristics which are always consistent at the population level. In addition to its discoid heads, *T. verdiensis* differs from *T. scaposa* in its dwarf habit, relatively short broad leaves, and long pilose vestiture. Other than *T. verdiensis*, there has been no report in *Tetraneuris* of entire populations, or series of populations, which are wholly discoid.

CONCLUSION

In *Tetraneuris* and in the closely related *Hymenoxys*, a syndrome of characteristics, some of these subtle, separate the various species. The degree of morphological distinction of *Tetraneuris verdiensis* is consistent with recognition at the species level within both of these genera. In short, *Tetraneuris verdiensis* is a relatively well-marked localized edaphic endemic of central Arizona.

ACKNOWLEDGMENTS

Gayle Turner provided the Latin diagnosis, and we are grateful to Mark Bierner and Ted Delevoryas for reviewing the manuscript. We would also like to thank John L. Anderson for additional information on the distribution of *Tetraneuris scaposa* (*Hymenoxys acaulis* var. *arizonica*) in the Verde Valley, and Elizabeth Mathews, Northern Arizona Zone Geologist, United States Forest Service, for clarification of the finer points of the geology of the Verde Valley.

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SYNOPTICAL STUDY OF THE *ACACIA ANGUSTISSIMA* (MIMOSACEAE) COMPLEX

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ABSTRACT

A taxonomic study of the widespread North American species, *Acacia angustissima*, is rendered. It is recognized as having six intergrading morphogeographical infraspecific categories, as follows: 1.) var. *angustissima*, a shrub or small tree occurring in tropical and subtropical mesic habitats along both sides of México from the states of Jalisco and Nuevo León southwards to Panamá; 2.) var. *hirta*, a rhizomatous perennial herb with simple stems occurring in the southeastern and south-central U.S.A.; 3.) var. *suffruticosa*, a suffruticose herb or shrub occurring mostly in the Sonoran desert regions of northeastern México; 4.) var. *chisosiana*, a divaricately branched subtortuose shrublet or shrub of north-central México and closely adjacent U.S.A. (New Mexico and trans-Pecos Texas); 5.) var. ***leucothrix*** (Standl.) B.L. Turner, *comb. & var. nov.*, a divaricately branched shrublet or shrub of the Tamaulipan scrublands of northeastern México and closely adjacent U.S.A.; and 6.) var. ***oaxacana*** B.L. Turner, *var. nov.*, a shrub or shrublet of the xeric scrublands of southern Pueblo and northern Oaxaca, México. A key to the varieties and a map showing their distribution is provided.

KEY WORDS: Mimosaceae, *Acacia*, U.S.A., México

Acacia angustissima (Mill.) Kuntze is a widespread common species of North America. It has been the subject of three relatively detailed studies (Wiggins 1942; Isely 1969; McVaugh 1987). Isely especially clarified relationships in the complex in northern México and the U.S.A. with his recognition of six intergrading varieties: *angustissima, hirta* (Nutt.) B.L. Rob., *texensis* (Torrey & A. Gray) Isely, *chisosiana* Isely, *suffrutescens* (Rose) Isely, and *shrevei* (Britt. & Rose) Isely. Of these, I combine var. *texensis* with var. *hirta*, and var. *shrevei* with var. *suffruticosa*. I have also recognized two additional infraspecific taxa, var. *leucothrix* and var. *oaxacana*. A key and map (Figure 1) to these various taxa follows, along with justification for the treatment, including partial synonymies where pertinent. More detailed information *re*

nomenclature and typification can be found in the papers of Wiggins (1942), Isely (1969), and McVaugh (1987).

Except as otherwise noted, the map (Figure 1) is based upon the several hundred specimens of the complex on file at LL, TEX. All of these have been appropriately annotated, including those of an intergradant nature.

KEY TO VARIETIES OF *ACACIA ANGUSTISSIMA*

1. Leaves with mostly 10-20 pairs of pinnae; plants of south-central and southeastern U.S.A. or tropical and subtropical México to Central America. ....(2)
   2. Suffruticose herbs mostly 0.3-1.0 m high; south-central and southeastern U.S.A .... var. *hirta*
   2. Shrublets, shrubs, or small trees mostly 2-7 m high. .... var. *angustissima*
1. Leaves with mostly 2-9(-10) pairs of pinnae; plants of more xeric montane or subdesert habitats, southwestern U.S.A., Sonoran and Chihuahuan deserts, Tamaulipan biotic province, and Puebla-Oaxacan shrublands.......................(3)
   3. Pinnae mostly 1-2 cm long; much-branched subtortuous shrublets of Chihuahuan Desert and Tamaulipan shrublands..................................(4)
      4. Older stems markedly striate with white to tan grooves; Chihuahuan Desert regions or north-central México, and closely adjacent New Mexico and Texas. .... var. *chisosiana*
      4. Older stems only weakly striate if at all; Tamaulipan biome scrublands of northeasternmost México (Tamaulipas and Nuevo León) and closely adjacent Texas. ....var. *leucothrix*
   3. Pinnae of well-developed leaves mostly 2-3 cm long; mostly straight-stemmed or weakly subtortuose suffruticose herbs or shrublets of the Sonoran Desert and Pacific slopes, or xeric montane habitats of southern Puebla and northern Oaxaca. ....(5)
      5. Pinnae mostly 2-4(-8) pairs; shrublets with subtortuous stems; southern Puebla and northern Oaxaca. ....var. *oaxacana*
      5. Pinnae mostly (4-)6-9(-10) pairs; suffruticose herbs to shrubs with mostly nontortuose stems; Sonoran Desert regions and Pacific slopes from Sonora to Nayarit and northern Jalisco..............................var. *suffrutescens*

ACACIA ANGUSTISSIMA (Mill.) Kuntze var. *ANGUSTISSIMA*

Acacia angustissima (Mill.) Kuntze, *Rev. Gen. Pl.* 3:47. 1896. *Mimosa angustissima* Mill., *Gard. Dict.* ed. 8. *Mimosa* no. 19. 1768. TYPE: MEXICO. Veracruz: 1731, *Houston s.n.* (BM), according to McVaugh (1987)

This is the most widespread and frequently encountered variety of the *Acacia angustissima* complex, occurring in tropical and subtropical habitats from northeastern Nuevo León, México and extending down the Gulf Coastal slopes to Panamá; on the Pacific slopes it occurs from southern Durango and probably closely adjacent Sinaloa to Panamá (Figure 1). The taxon is readily recognized by its large habit (2-8 m),

elongate nontortuose stems, and large leaves with numerous pinnae (mostly 10-20 pairs).

Wiggins (1942) provided a partial list of synonyms for the taxon (including *Acacia angustissima* subsp. *smithii* [Britt. & Rose] Wiggins, which I cannot recognize), as did McVaugh (1987). Additional synonyms are likely to be disinterred from among the numerous names proposed for the North American elements of *Acacia*. The type of *A. angustissima* was obtained from Veracruz, México by Houston in 1731 and is discussed in more detail by Wiggins (1942).

ACACIA ANGUSTISSIMA (Mill.) Kuntze var. *CHISOSIANA* Isely

Acacia angustissima (Mill.) Kuntze var. *chisosiana* Isely, Sida 3:370. 1969.

Isely, although not having examined living plants, recognized the distinctiveness of this taxon. Turner (1959) erroneously included most such material in his concept of *Acacia texensis* Torrey & A. Gray. The latter name is typified by material from near New Braunfels, Texas, and is nothing more than forms of var. *hirta*, having somewhat fewer pinnae.

The var. *chisosiana* is largely confined to the Chihuahuan Desert regions of trans-Pecos Texas, New Mexico, and north-central México (Figure 1). It appears to intergrade but slightly into var. *hirta* in the eastern portion of its range and perhaps into var. *suffrutescens* in the western parts of its range. Indeed, it is possible that future workers might consider it specifically distinct; if so, this would perhaps necessitate the elevation of varieties *leucothrix* and *oaxacana*, this triad being superficially similar among themselves, but unlikely to represent a monophyletic element, to judge from their distributions.

ACACIA ANGUSTISSIMA (Mill.) Kuntze var. *HIRTA* (Nutt.) B.L. Rob.

Acacia hirta Nutt., *in* Torr. & Gray, *Fl. N. Amer.* 1:404. 1840. *Acacia angustissima* (Mill.) Kuntze var. *hirta* (Nutt.) B.L. Rob., Rhodora 10:33. 1908. Type collected by Nuttall in eastern Oklahoma or closely adjacent Arkansas.

Acacia texensis Torr. & Gray, *Fl. N. Amer.* 1:404. 1840. *Acacia angustissima* (Mill.) Kuntze var. *texensis* (Torr. & Gray) Isely, Sida 3:372. 1969. Type collected by Lindheimer in central Texas, vicinity of New Braunfels, Comal Co.

Isely (1969) recognized *Acacia texensis* as varietally distinct, distinguishing it from var. *hirta* by its purportedly smaller leaves with fewer pinnae (mostly 4-6 pairs vs. 9-15 pairs), ignoring intermediates between these. I view Isely's var. *texensis* to be but sporadic leaf forms of the widespread var. *hirta*, the smaller leaves usually occurring on secondary shoots which arise from cutover or browsed plants, although some such plants must represent intermediates between var. *chisosiana* and var. *hirta* along their regions of contact.

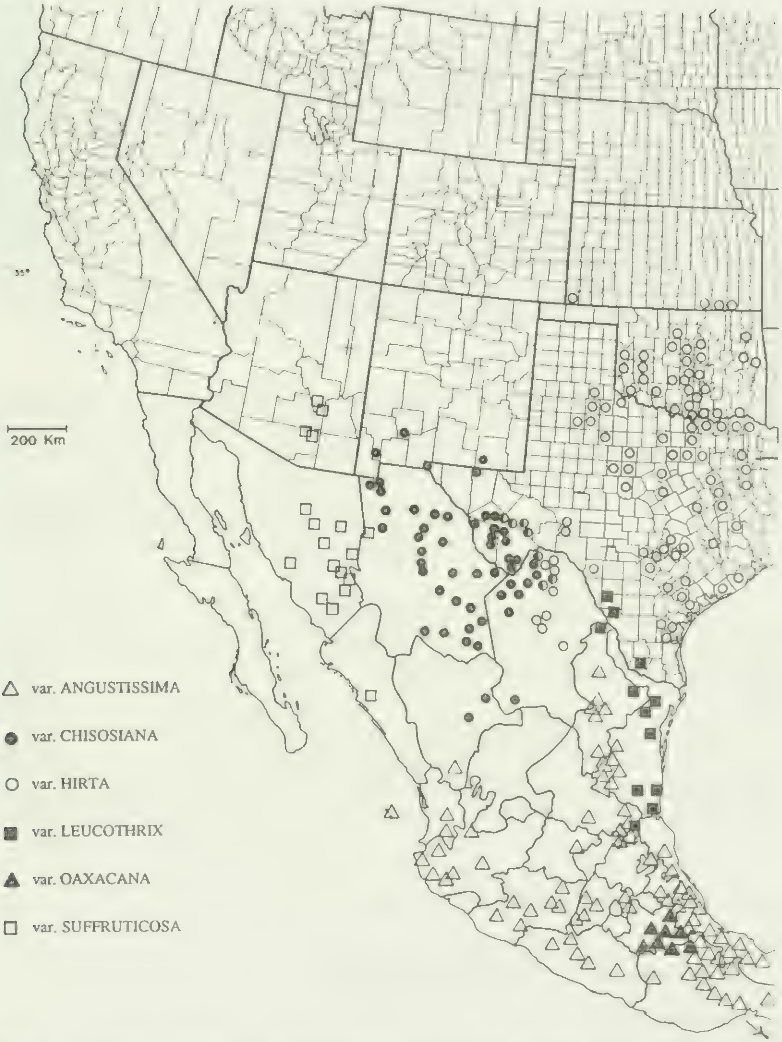

Figure 1. Distribution of the infraspecific categories of *Acacia angustissima*. All of these apparently intergrade to some extent in areas of close proximity, but only the half-closed circles documented this for var. *chisosiana* and var. *hirta* is shown on the map. Arrows show extension of the taxa to regions outside of the bounds of the map area. The map is based largely upon specimens at LL, TEX, except for most of the open circles in Oklahoma and Nebraska, these having been extracted from the map portrayed in Barkley (1977).

ACACIA ANGUSTISSIMA (Mill.) Kuntze var. ***LEUCOTHRIX*** (Standl.) B.L. Turner, *stat. & comb. nov.* BASIONYM: *Acacia leucothrix* Standl., Contr. U.S. Natl. Herb. 20:185. 1919. The type was collected in easternmost San Luis Potosí, México (at San Dieguito) in 1904 by Palmer. (Paratypes examined: *Pringle 9717* [3 sheets, LL, TEX]).

This taxon is well-represented at LL, TEX. Dr. M.C. Johnston was perhaps the first to recognize its affinity, at least by annotations on several sheets at LL, TEX. Standley in his protologue compared his new taxon with *Acacia cuspidata* Schlecht., but the latter presumably does not belong to the *A. angustissima* complex if we are to believe that the leaf petiole is glandular, as given in its type description.

ACACIA ANGUSTISSIMA (Mill.) Kuntze var. ***OAXACANA*** B.L. Turner, *var. nov.* TYPE: MEXICO. Oaxaca: 5 km al SE de Cuicatlán, por la desviación a San Pedro Ocotipac, Selva Baja Caducifolia, ca. 760 m, 27 Aug 1980, *F.G. Madrano, et al. F-1568* (HOLOTYPE: TEX!).

Similis *A. angustissimae* (Mill.) Kuntze var. *leucothrix* (Standl.) B.L. Turner sed habens folia majora cum pinnis longioribus (2-3 cm vice 1-2 cm) et caules minus tortos.

ADDITIONAL SPECIMENS EXAMINED (9 sheets): MEXICO. Puebla: *Salinas T. & Dorando R. F-3097* (TEX); *Sousa 9390* (TEX); *Tenorio L. 8014* (TEX); *Tenorio L. 14158* (TEX). Oaxaca: *Magallanes 53, 196* (TEX); *Salinas T. 4635, 4846, 4861* (TEX).

This taxon is superficially similar to var. *leucothrix* but has mostly larger leaves with longer pinnae (2-3 cm long vs. 1-2 cm long) and less tortuose stems. The collections by Magallanes (cited above) differ from most of the other collections in having mostly 4-8 pairs of pinnae, otherwise the plants are scarcely distinguishable.

ACACIA ANGUSTISSIMA (Mill.) Kuntze var. *SUFFRUTESCENS* (Rose) Isely

Acacia suffrutescens Rose, Contr. U.S. Natl. Herb. 12:409. 1909. *Acacia angustissima* (Mill.) Kuntze var. *suffrutescens* (Rose) Isely, Sida 3:372. 1969. The type was collected in Santa Cruz Valley, near Tucson, Arizona, U.S.A.

Acacia lemmonii Rose, Contr. U.S. Natl. Herb. 12:409. 1909. *Acacia angustissima* (Mill.) Kuntze subsp. *lemmonii* (Rose) Wiggins, Contr. Dudley Herb. 3:230. 1842. The type was collected by Lemmon in the Huachuca Mts., Cochise Co., Arizona, U.S.A.

Acaciella shrevei Britt. & Rose, N. Amer. Fl. 23:105. 1928. *Acacia angustissima* (Mill.) Kuntze var. *shrevei* (Britt. & Rose) Isely, Sida 3:371. 1969. The type was collected by Shreve in the Huachuca Mts., Cochise Co., Arizona, U.S.A.

As noted in the above synonymy, Isely (1969) recognized a var. *shrevei* from among this complex, largely distinguished by its purportedly shrubby habit and more

venose leaflets. I cannot see that such habitat forms might be meaningfully segregated, nor does leaflet venation serve to mark the Huachuca Mt. specimens as distinct, there being much sporadic variation of this character, especially in México. Indeed, McVaugh (1987) calls attention to similar venose forms in western México; he called such material var. *texensis* (Torr. & Gray) Isely. It is likely, however, that the plants concerned are southern elements of my concept of var. *suffrutescens*, the latter presumably intergrading into var. *angustissima* in this region.

It should also be noted here that *Acaciella painteri* Britt. & Rose, discussed by McVaugh (1987, p. 125) presumably belongs to the var. *suffruticosa* complex. The limits of the latter taxon in Sinaloa, Durango, Zacatecas, Nayarit, and Jalisco is in much need of additional study, especially populational investigations.

ACKNOWLEDGMENTS

I am grateful to Gayle Turner for the Latin diagnosis, and to her and Ted Delevoryas for reviewing early drafts of the manuscript.

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SYNOPSIS OF SECTION *AXILLARIS* OF *SALVIA* (LAMIACEAE)

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ABSTRACT

The wholly Mexican sect. *Axillaris* Epling of the genus *Salvia* is revised. It is treated as having a single species, *S. axillaris* Benth., with three morphogeographical infraspecific units: var. *axillaris* of southern Puebla and closely adjacent Oaxaca; var. ***hidalgoana*** B.L. Turner, *var. nov.*, of southern Hidalgo; and var. ***potosina*** B.L. Turner, *var. nov.*, of Durango, Zacatecas, Aguascalientes, San Luis Potosí, Guanajuato, Querétaro, and southwestern Hidalgo. An illustration of the species and a key to the varieties is provided, along with a map showing their distributions.

KEY WORDS: *Salvia*, sect. *Axillaris*, Lamiaceae, México, systematics

Attempts to identify various species of *Salvia* from México has led to the detailed examination of *S. axillaris* Benth., a very distinct species which was treated by Epling (1937) as belonging to the monotypic section *Axillaris*. Results of this investigation follow.

SECTION AXILLARIS Epling (1937)

Subsection *Axilliflorae* Benth., *Lab. Gen. et Sp.* 270. 1833.

SALVIA AXILLARIS Moc. & Sesse *ex* Benth., *Lab. Gen. et. Sp.* 270. 1833.

My inclusive description of this species is about the same as that provided by Epling (1937) and no redescription is needed here. I have, however, recognized three morphogeographical varietal elements within the taxon. Some workers might prefer to treat these as distinct species, especially since they occupy different noncontiguous ecogeographical settings and scarcely can be said to intergrade. There can be no

question, however, that these several taxa might not be more closely related one to the other than to yet other species.

KEY TO VARIETIES

1. Filaments of stamens pubescent with coarse hairs; stem vestiture of mostly eglandular spreading hairs. ....var. *potosina*
1. Filaments of stamens glabrous (rarely a few basal hairs); stem vestiture of long glandular hairs, or short eglandular, mostly down-curved or arcuate hairs.
   2. Vestiture at midstem mostly composed of spreading glandular trichomes 0.3-0.5 mm high; midstem leaves weakly nervate, mostly 5-7 mm long, 2-3 times as long as wide; Hidalgo. ....var. *hidalgoana*
   2. Vestiture at midstem composed of short up-curved or down-curved eglandular hairs 0.1-0.2(-0.3) mm high; midstem leaves strongly nervate, 6-12 mm long, 3-5 times as long as wide; s Puebla and n Oaxaca.................... var. *axillaris*

SALVIA AXILLARIS Moc. & Sesse *ex* Benth. var. *AXILLARIS* Figure 1.

Salvia axillaris Moc. & Sesse *ex* Benth., *Lab. Gen. et Sp.* 270. 1833. TYPE: MEXICO. Puebla: rocky soils near Tepeaca, 1787-1804, *Sesse & Mocino 188* (HOLOTYPE: Lambert herbarium; Isotype fragment: F!).
Salvia cuneifolia Benth., *Lab. Gen. et Sp.* 270. 1833. TYPE: MEXICO. Oaxaca: w/o locality or date, *Karwinski s.n.* According to Epling (1939), who treated *S. cuneifolia* as synonymous with *S. axillaris*, the type of this taxon is in the Herbarium at Monaco.

I have examined 25 sheets of this variety (10 from Puebla; 15 from Oaxaca, as mapped in Figure 2) and, except for *Dorado F 2886* (MICH), all had glabrous stamens, strongly nervate linear-oblanceolate leaves (except for juvenile or leaf-litter leaves), and vestiture of stems with short, mostly eglandular hairs 0.1-0.2(-0.3) mm high.

SALVIA AXILLARIS Moc. & Sesse *ex* Benth. var. ***HIDALGOANA*** B.L. Turner, *var. nov.* TYPE: MEXICO. Hidalgo: bare hills above Pachuca, 18 Jul 1898, *C.G. Pringle 6905* (HOLOTYPE: LL!; Isotypes: F!,UC!).

Differt *Salviae axillari* Moc. & Sesse *ex* Benth. var. *axillaris* habendo folia parviora et proportione latiora et indomentum calium cum trichomatibus glanduliferis effusis 0.3-0.5 mm altis.

REPRESENTATIVE SPECIMENS: MEXICO. Hidalgo: 17 mi W of Tulancingo (at village of Jalapillo) along highway 130, 27 Jul 1969, *Bierner & Turner 128* (TEX); 7 km N of Pachuca, 4 Aug 1963, *Galvan s.n.* (MICH); Sierra Pachuca, 9000 ft, 26

Figure 1. *Salvia axillaris* var. *axillaris* (Puebla: *Tenorio 14113* [TEX]).

Figure 2. Distribution of varieties of *Salvia axillaris*: var. *axillaris* (open triangles); var. *hidalgoana* (closed circles); var. *potosina* (open circles).

Aug 1902 (?), *Pringle 11114* (GH,MICH); Sierra de Pachuez, 21-22 Jul 1901, *Rose & Hay 5632* (UC); 2 km S of Epazoyucan, 1 Aug 1971, *Rzedowski 28311* (MICH); 3 km SE of Epazoyucan, 19 Jul 1963, *Rzedowski 16909* (MICH). Veracruz: "cerros arriba de Santiago", 20 Jul 1971, *Nevling & Gomez-Pompa 1866* (F,MEXU).

Epling (1937) included the type of this taxon in his concept of *Salvia axillaris*. Both of the above cited collections have glabrous filaments, much as var. *axillaris*, but possess smaller, less venose leaves, and glandular-pubescent stems and foliage. Indeed, were it not for the glabrous filaments of var. *hidalgoana*, I would probably have recognized var. *potosina* as specifically distinct, since the former more or less links the latter with var. *axillaris*.

SALVIA AXILLARIS Moc. & Sesse *ex* Benth. var. ***POTOSINA*** B.L. Turner, *var. nov.* TYPE: MEXICO. Guanajuato: Mpio. San Felipe Torresmochas, Sierra El Cubo, 5 km E de El Cubo, 2370 m, 5 Oct 1979, *J. Garcia P., E.J. Lott, y A. Rebolledo V. 1168* (HOLOTYPE: TEX!; with 12 isotypes widely distributed [according to label data]).

Differt *Salviae axillari* Moc. & Sesse *ex* Benth. var. *axillaris* habendo stamina cum filamentis grosse pubescentibus (vice glaberorum) et indumentum calium cum pilis eglandulosis effusis 0.3 mm altis.

REPRESENTATIVE SPECIMENS: MEXICO. Aguascalientes: just E of Asientos, 4-8 Sep 1967, McVaugh 23666 (MICH). Durango: mountains S of La Purisima, 26 Aug 1939, *Shreve 9193* (GH,MICH,UC). Guanajuato: W of Guanajuato on the road to Cristo Rey (a shrine), 4 Oct 1974, *Robins 74119* (GH,TEX). Hidalgo: Napala, 1 Aug 1914, *Salasar s.n.* (MEXU). Querétaro: 15 mi SE of Querétaro, 6000 ft, 3 Aug 1956, *Fearing & Thompson 149* (TEX). San Luis Potosí: ca. 23 road mi N of Charcos, 7900 ft, 5 Sep 1971, *Henrickson 6408* (LL); 22 km SW of San Luis Potosí on the highway to Guadalajara, 2100-2300 m, *Johnston, et al. 12272a* (LL); SW of San Luis Potosí, 2 mi SW of dam on highway 80, 5 Jul 1971, *Verhoek-Williams, et al. 504* (TEX). Zacatecas: 2 mi W of Sombrerete, 26 Sep 1959, *Soderstrom 739* (MICH).

All of the above cited specimens possessed stamens with coarsely pubescent filaments and stems with a widely spreading vestiture of mostly eglandular hairs 0.3-0.8 mm high.

Epling (1937) included elements of the present variety in his concept of *Salvia axillaris*, to judge from his citations. As noted under var. *hidalgoana*, I would probably have considered var. *potosina* specifically distinct were it not for the former, which possesses the foliage of var. *potosina* but the staminal hairs of var. *axillaris*.

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RUSSELIA MANANTLANA (SCROPHULARIACEAE), A NEW SPECIES FROM JALISCO, MEXICO

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ABSTRACT

A new species, ***Russelia manantlana*** B.L. Turner, is described from Sierra de Manantlán, Mpio. Cuautitlán, Jalisco, México. It is closely related to *R. teres* Lundell from Coalcomán, Michoacán, but differs by characters of the inflorescence and foliage.

KEY WORDS: Scrophulariaceae, *Russelia*, México, systematics

Routine identification of Mexican scrophs has revealed the following novelty.

RUSSELIA MANANTLANA B.L. Turner, *spec. nov.* TYPE: MEXICO. Jalisco: Mpio. Cuautitlán, 2-3 km NE of Telcruz, ca. 1300 m, 1 Feb. 1987, *R. Cuevas & M. Rosales 1785* (HOLOTYPE: WISC! [2 sheets]). The holotype consists of two sheets, sheet 1 having strictly ternate leaves (3 to a node) and sheet 2 having strictly opposite leaves. Except for the leaf arrangement, the plants are almost identical. It is likely that these represent collections from different plants at the locality concerned, but, if so, these bear the same collection number. Alternatively the stems concerned may have been culled from the same plant; this sort of variation is not especially uncommon among species of *Russelia*.

Similis *R. tereti* (*R. teres*) Lundell sed habens inflorescentiam multo diffusiorem spertioremque, laminas foliorum longiores (7-9 cm vice 4-6 cm), et petiolos longiores (4-6 mm vice 1.0-2.5 mm).

Erect herbs 80-90 cm high. Midstems terete, without angles, purplish-black, glabrous, 3-4 mm across. Midstem leaves ternate (sheet 1) or opposite (sheet 2); petioles 4-6 mm long, minutely pubescent; blades ovate-lanceolate, 7-9 cm long, 2.5-3.5 cm wide, glabrous or nearly so above and below, finely reticulate and not resinous lepidote, the margins irregularly serrate. Flowers arranged in open axillary or terminal dichasial cymes, the primary peduncles glabrous, 3.0-4.5 cm long, the ultimate pedicels glabrous, 2-5 mm long. Calyces (flowering) 2.5-3.0 mm long, glabrous, the

lobes 2.0-2.5 mm long, ovate below, the apices attenuate-filiform. Corollas red, tubular, 7-8 mm long, 2.0-2.5 mm wide, glabrous, the lobes 1-2 mm long, obtuse or rounded apically. Fruiting material not available.

In Carlson's monographic treatment of *Russelia* (Fieldiana: Bot. 29:231-292. 1957.), this taxon will key to or near *R. teres* Lundell, a species known only from the village of Aquilla, in the vicinity of Coalcomán, Michoacán. It differs from the latter in having a much more open diffuse inflorescence, and longer (7-9 cm vs. 4-6 cm) more attenuate leaf blades with longer petioles (4-6 mm long vs. 1.0-2.5 mm long).

ACKNOWLEDGMENTS

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PAEPALANTHUS SUBG. *XERACTIS* (ERIOCAULACEAE): NOTES AND NOMENCLATURAL CHANGES

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ABSTRACT

Critical new records are cited for *Paepalanthus clausenii* Hensold and *P. dianthoides* Koern. *Paepalanthus chlorocephalus* f. *parviflorus* Hensold is elevated to species status as ***P. parviflorus*** (Hensold) Hensold. A *nomen novum*, ***Paepalanthus stuetzelii*** Hensold, is provided for the later homonym *Paepalanthus lanuginosus* Hensold. A revised description and sectional placement is provided for *Paepalanthus xiphophyllus* Ruhland, with discussion.

KEY WORDS: Eriocaulaceae, *Paepalanthus*, Brazil, systematics

Paepalanthus subg. *Xeractis* is a group of 28 species endemic to the Serra do Espinhaço of Minas Gerais, Brazil. Additional data have accumulated since the publication of a monograph of subg. *Xeractis* (Hensold 1988), and a few notes and corrections in the taxonomy are in order. Publication of these notes is made timely by the upcoming treatment of the subgenus for the Flora of the Serra do Cipó, Brazil (Boletim de Botânica, Universidade de São Paulo, vol. 9 f.f.).

Paepalanthus clausenii Hensold

Additional specimen: BRASIL. Minas Gerais: Itabirito, Pico do Itabirito, entre afloramentos de quartzito, 16 Oct. 1993, *leg. W. A. Teixeira, BHCB hb. no. 24258* (BHCB,F). [Duplicates possibly distributed in error as *BHCB 26523*, *P. speciosus*].

This is a welcome verification that this species is not extinct. It has been known until now only from three Claussen collections made around 1840, probably from the same locality.

Paepalanthus dianthoides Koern.

Additional specimen: BRASIL. Minas Gerais: Santana do Riacho, Serra do Cipó, Rodovia Belo Horizonte-Conceição do Mato Dentro: 12 km NE de Cardeal Mota, Alto Congonhas, 3 km E del camino, *M.M. Arbo et al. 4742* (CTES).

Until now, this species was reported with certainty only from the Serras do Garimpo and Caraça, in the southern reaches of the Serra do Espinhaço near Santa Bárbara. This is the first collection from the extremely well-collected Serra do Cipó, where it was found growing at the edge of gallery forest. The gallery forests within the Serra do Cipó may provide similar habitat to the Serras to the south, where the vegetation is generally denser and shrubbier.

The Serra do Cipó specimen differs from the Santa Bárbara material in having leaves that are softly pilose above and not evidently ciliate, the involucral bracts weakly hygroscopic and more densely hairy on the inner surface, and the floral bracts and sepals very pale. The sepals are a "dirty cream" in comparison to most other species with cream-colored flowers, but the shade is so pale that it would surely key to *Paepalanthus superbus* Ruhland in the monograph, a species known only from farther north in the Serra do Cipó. *Paepalanthus dianthoides*, including the Serra do Cipó plant, can also be distinguished from *P. superbus* by the sharp-cuspidate leaves, the white anthers, and the shallow short-bracteate involucres, as well as by several technical characters including leaf anatomy.

Paepalanthus parviflorus (Hensold) Hensold, *comb. & stat. nov.* BASIONYM: *Paepalanthus chlorocephalus* A. Silveira f. *parviflorus* Hensold, Syst. Bot. Monogr. 23:117-118. 1988.

My original treatment of this taxon as a form of *Paepalanthus chlorocephalus* depended on the assumption that it represented no more than a simple mutational variant of that species, co-existing with it in polymorphic equilibrium. But this seems to me now to be an extravagant assumption, without good evidence. If I had not been influenced by the sight of an intermingled population of these in the field (at km 125 on the Rodovia Belo Horizonte - Conceião do Mato Dentro), where they were blooming simultaneously and virtually indistinguishable at first sight, I would probably have treated them as separate species from the beginning.

The two species are distinguished by several characters and general tendencies, discussed in detail in the monograph. From a biosystematic viewpoint the low seed production observed in *Paepalanthus parviflorus* relative to that of *P. chlorocephalus* is of some interest, as is the fact that hybrids with *P. nigrescens* A. Silveira are known only with *P. parviflorus*, and not with the much more common *P. chlorocephalus* (Hensold 1988). In addition, *P. parviflorus* occurs alone in the vicinity of Morro do Breu, north of the known range of *P. chlorocephalus*. Cytological studies of the two taxa would be desirable.

Paepalanthus stuetzelii Hensold, *nom. nov.* *Paepalanthus lanuginosus* Hensold, Syst. Bot. Monogr. 23:140. 1988., ***non*** *Paepalanthus lanuginosus* (Bong.)

Koern. *in* Martius, *Fl. Bras.* 3(1):428. 1863., =*Leiothrix curvifolia* Ruhland var. *lanuginosa* (Bong.) Ruhland.

Dr. Thomas Stützel kindly pointed out to me that I had overlooked the prior application of the name *Paepalanthus lanuginosus*, and published a later homonym. The new name hereby honors his substantial contributions to the study of Eriocaulaceae.

Paepalanthus xiphophyllus Ruhland -- TYPE: BRASIL. Minas Gerais: Serra da Gandarella, *leg. Sena, hb. Schwacke 14578*, acc. 25.IV.1902 (HOLOTYPE: B!).

I had not seen the type of this species earlier, because of my assumption that it had been destroyed. In fact, the eriocaul types at B are largely extant. Examination of the original label confirms the type locality as the Serra da Gandarella, a ferriferous range ca. 17 km west of the Serra do Caraça, erroneously cited in the protologue as the "Serra da Gandavelha."

Examination of the type material necessitates the following changes in the taxonomic treatment.

Revised placement: Transferred from ser. *Albidi* to ser. *Fuscati*. (But see discussion below.)

Revised description: Stems elongate, 18 cm in the type, sericeo-tomentose. Leaves ca. 6 cm long, 8-12 mm wide, lanceolate, acute, chartaceous, densely striate-sericeous to arachno-tomentose on both surfaces, but pubescence not completely obscuring the leaf surface. Inflorescences 2 in the type. Peduncle sheaths about equalling the leaves and pubescent like them, acute, apparently open nearly to the base. Peduncles about 5 cm long, robust, densely sericeous. Involucres shallow, the bracts in only about 3 series; involucral bracts dark gray-brown, deltoid, acute to acuminate, the lower only slightly smaller than the upper and similar in shape, those of the upper series about 6 mm long, 3-4 mm wide, surpassing capitulum by ca. 3 mm; pubescence of long silky appressed hairs on abaxial surface and of coarse opaque hairs limited to the marginal area and apex on the adaxial surface, otherwise shiny and glabrous within. Capitula 10-12 mm diam. Trichomes of bract and sepal apices with the apical cell linear-clavate (like a baseball bat), ca. 160-180 μ long, 40 μ wide, the inner walls ornamented. Staminate flowers: Sepals dark brown (subhyaline and blackened spadiceous), elliptic, broadly acute, ca. 2.8 mm long, fused in the basal 0.6 mm; tufted with trichomes at apex ca. 0.5-0.6 mm long, and long-ciliate along margins of upper half, otherwise glabrous. Corolla cream (or brownish-hyaline), lacking localized granular pigmentation, ca. 3 mm, short-stipitate, the stipe ca. 0.5 mm, the lobes long-acuminate, ca. 0.6 mm; glabrous within, the sinuses obscurely lobed to entire and very sparsely ciliate. Anthers brown, exsert, ca. 0.4 mm. Appendages of the style (*i.e.*, pistillodes) truncate-infundibular, brown, short-papillate, ca. 0.6 mm long. Pistillate flowers not seen.

This species lacks the trichomes on the inner surface of the corolla of the staminate flowers which characterize all other known species of subg. *Xeractis*, and although the involucral bracts surpass the capitulum, they are pubescent only near the margins on

the adaxial surface and are not hygroscopic. The deeply split peduncle sheath is also an unusual characteristic.

In terms of phenetic relationship, *Paepalanthus xiphophyllus* is more similar to *P. superbus* of subg. *Xeractis* ser. *Fuscati* than to any other species, and for this reason I provisionally retain it in the subgenus. It shares with this species similar habit, leaf pubescence and anatomy, sepal morphology, linear-clavate (baseball-bat-shaped) floral trichome apical cells, and staminate corollas with acuminate lobe apices, and without localized granular pigmentation. However, *P. superbus* and its two other closest relatives, *P. ater* Silveira and *P. revolutus* Hensold, are endemic to the northern part of the Serra do Cipó, relatively distant from the cited locality of *P. xiphophyllus*.

Paepalanthus xiphophyllus also may have affinities to a group of species recently excluded from subg. *Xeractis* (Hensold 1988), including *P. acuminatus* Ruhland, *P. harmsii* Ruhland, and *P. leiseringii* Ruhland of the Serra de Ibitipoca, as well as *P. paulinus* Ruhland of the Serra do Espinhaço and *P. xanthopus* A. Silveira of the Serra do Cabral. All these taxa have rather large radiating, but non-hygroscopic, involucral bracts, and in several, the corollas of the staminate flowers are ciliate at the upper margin (although not pilose within). However, in most of these taxa (not verified for *P. xanthopus*) the stylar appendages have long hair-like papillae. The long-stemmed habit, brown (although relatively small) anthers, and short-papillate stylar appendages of *P. xiphophyllus* suggest it occupies an intermediate position between this group of taxa and subg. *Xeractis*.

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LONGLEAF PINE (*PINUS PALUSTRIS* MILL.) GROWTH IN BOGS

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ABSTRACT

We measured growth rates and mortality of longleaf pine planted in a clear-cut bog and in an adjacent clear-cut mesic site. Longleaf pine grew more slowly and had a higher mortality in the bog than in the drier site. Longleaf appears to be poorly adapted to saturated soils.

KEY WORDS: Longleaf pine, *Pinus palustris*, tree growth, Kisatchie National Forest, bog, soil moisture

INTRODUCTION

In the West Gulf Coastal Plain, bogs are open communities (Nixon & Ward 1986; Bridges & Orzell 1989; MacRoberts & MacRoberts 1993; Harcombe, *et al.* 1993). They have a diverse herbaceous layer and, if frequently burned, are almost devoid of woody vegetation. Often a few scattered and stunted longleaf pine (*Pinus palustris* Mill.), an associated species of bog habitats in the West Gulf Coastal Plain, occur in them. In two previous papers we considered the problem of what keeps bogs open and why a few longleaf pines survive and grow to maturity in them (MacRoberts & MacRoberts 1990, 1993; see also Streng & Harcombe 1982).

While examining a bog on the Winn District of the Kisatchie National Forest, Natchitoches Parish, Louisiana, that had been clear-cut and replanted with longleaf pine, we noted that longleaf in the bog were growing much more slowly than in adjacent drier areas. This offered the opportunity to document some aspects of bog dynamics. We gathered quantitative data on the growth and survival of longleaf pine in the bog and in adjacent drier areas to further explore the factors involved in keeping bogs open.

METHODS

The bog is located in T13N R6W Sec. 26 and measures about 1.0 ha. It and the surrounding 20 ha. were clear-cut in 1990. The entire site was prepared by drum chopping followed by a prescribed burn and was machine replanted with bare-root longleaf pine seedlings in early 1991. The replanting was evenly distributed (1.8 m × 2.4 m), at a density of 2200 seedlings per ha. Since initial planting, the site has been burned twice. The first burn occurred in the winter (January/February) of 1992 and the second in the early spring (April) of 1994. The bog is located in the middle of the eastern section of the clear-cut. It is on a slight slope of about 3-5° and is seepage fed: while not inundated, the soil is permanently saturated. Common species in the bog include *Aletris aurea* Walt., *Burmannia capitata* (Walt.) Mart., *Drosera capillaris* Poir., *Eriocaulon decangulare* L., *Lachnocaulon anceps* (Walt.) Morong., *Lycopodium* spp., *Marshallia graminifolia* (Walt.) Small subsp. *tenuifolia* (Raf.) L. Watson, *Pinguicula pumila* Michx., *Polygala cruciata* L., *Pogonia ophioglossoides* (L.) Juss., *Rhexia petiolata* Walt., *Rhynchospora* spp., *Sabatia gentianoides* Ell., *Utricularia subulata* L., *Xyris baldwiniana* Schultes, and *Viola primulifolia* L. For further information on nearby bogs and the area in general see MacRoberts & MacRoberts (1988) and Martin & Smith (1991).

The site is not seeding in. All pines in the study area were planted and there are no seed trees within hundreds of meters.

In November 1995 we established five permanent circular plots. Plot 1, measuring 0.0728 ha., was established in the center of the bog. Four plots (Plots 2-5) each one quarter the size of Plot 1 were established in the drier (non-bog) area surrounding the bog at each cardinal point relative to Plot 1. Since the bog slopes westward, the eastern plot (Plot 2) was upslope, the western plot (Plot 4) was downslope, and two plots were at the same elevation as Plot 1 north and south (Plots 3 and 5, respectively). Each non-bog plot was located 25 to 50 meters outside the bog.

The height of all longleaf pines, the only trees present, was measured in all plots in November 1995 and 1996. Height to the nearest dm was measured from ground to tip of the terminal bud. Grass stage seedlings (without stem) were counted in the 1 dm class.

We examined all pines within the plots for evidence of stress and disease. This included signs of brown spot, stunted (short) or chlorotic needles, and small or absent growth bud.

For additional data on stress and disease, we examined fifty randomly selected grass stage individuals in the bog and recorded whether they showed any of these characteristics.

Finally, we made a visual examination of the growing conditions of 21 of the tallest pines in the bog to see if they were growing in wetter or drier areas, or in areas that were either higher or lower than the surrounding substrate.

Four soil samples from the upper 15 cm were taken from within the bog plot, and one each from the surrounding Plots 2-5 to see if there were any differences in soil chemistry between bog and non-bog plots. Samples were analyzed by A. & L. Agricultural Laboratories, Memphis, Tennessee.

RESULTS

On November 28, 1995 the bog plot had 55 longleaf pines; the four non-bog plots had a combined total of 89 longleaf pines. Plots 2-5 had a higher density of longleaf than Plot 1: Plot 2 = 20, Plot 3 = 20, Plot 4 = 22, Plot 5 =27. The original planting density was 160 seedlings per 0.0728 ha. Thus, survival in the bog plot was 34% and in the non-bog plots, 56%.

On November 13, 1996 we resurveyed the plots. Plot 1 had 49 longleaf pines; Plots 2-5 had a combined total of 86 longleaf pines. The number of trees in the non-bog plots was: Plot 2 = 19, Plot 3 = 18, Plot 4 = 22, and Plot 5 = 27. By 1996, survival rate had changed to 31% in the bog plot and 54% in non-bog plots.

Between 1995 and 1996 there was a loss of six trees in the bog plot (11% of the total) and a loss of only three trees in the non-bog plots (3% of the total).

Table 1 summarizes size data for longleaf pines in 1995 and 1996.

Table 1. Longleaf pine heights (in percentage) inside and outside bog.

Height class in dm	In Bog		Outside Bog	
	1995	1996	1995	1996
1-5	85	62	25	12
6-10	9	18	30	12
11-15	6	10	38	17
16-20		4	5	22
21-25		6	2	28
26-30				7
31-35				1
36-40				1

In 1995, the mean height for the bog plot longleaf pines was 2.9 dm (SD = 3.1 dm) and that for non-bog plot longleaf was 9.3 dm (SD = 5.1 dm). In 1996, these figures were 5.9 dm (SD = 5.8 dm) and 16.7 dm (SD = 7.9 dm), respectively. In other words, the trees in the bog were one-third the height of those in the mesic areas. We used the SAS NPAR1WAY procedure to compare the differences between bog and non-bog populations in each year's samples (SAS /STAT 1987). Calculations of linear rank statistics are based on Wilcoxon, Median, Van der Waerden, and Savage. In addition, NPAR1WAY calculates two statistics -- Kolmogorov-Smirnov and Cramer-von Mises -- based on the empirical distribution of the sample. In all the statistics, P = .0001 level.

Our observations on stress showed that 28 (51%) of the longleaf in Plot 1 were stressed or diseased; whereas only three (3%) of the trees in Plots 2-5 showed signs of stress and disease. It is interesting that two of the affected individuals outside the bog were grass stage.

Of the 50 grass stage longleaf examined in the bog as a whole for stress or disease, 45 (90%) showed one or more signs of disease and /or stress: 21 had brown spot disease, 40 had chlorotic needles, 39 had stunted needles, and 40 showed little or no bud development.

Twenty of the 21 tallest trees in the bog grew on higher and drier ground than the surrounding landscape, a microgeographical difference measurable in centimeters, caused by previous timbering and replanting that left the ground slightly furrowed and hummocked.

Soil data are presented in Table 2. There appeared to be no difference in soil chemistry among the plots (Wald-Wolfowitz runs test).

DISCUSSION

What explains the difference in number and height of longleaf pines between the bog plot and the four non-bog plots?

Shading can be excluded since the longleaf pines in the study area were sufficiently spaced so that all received equal solar radiation. Soil differences also seem to be unimportant since soils in all plots belong to the same morphological type (Martin, *et al.* 1990) and had the same general chemical composition (although possible trace element differences in soil chemistry can never be totally ruled out). However, since it is generally agreed that longleaf pine grows well on relatively poor soils (Wahlenberg 1946), it would appear that soil chemistry is probably not the important factor in explaining the difference in tree growth.

This leaves several interrelated factors: stress, fire, and disease. While growth rates of longleaf pine apparently have not been experimentally studied along a continuous moisture gradient (Fowells 1975; Wahlenberg 1946; Bruser pers. comm.),

Table 2. Soil characteristics of bog and non-bog plots.

		Exchangeable Ions (ppm)				
Sample	pH	P	K	Ca	Mg	OM%
Plot 1						
Sample 1	4.8	2	27	120	30	4.2
Sample 2	4.6	1	21	80	21	4.7
Sample 3	4.9	2	23	60	16	1.6
Sample 4	4.9	2	21	100	27	2.3
Mean plot 1	4.8	1.8	23	90	23.5	3.2
Plot 2	5.2	2	28	180	28	2.5
Plot 3	5.0	2	25	210	36	3.9
Plot 4	4.9	3	26	80	20	1.3
Plot 5	5.0	3	29	60	15	0.9
Mean plots 2-5	5.0	2.5	27	132.5	24.8	2.2

site condition reports generally recognize that longleaf pine, while showing a wide range of habitat tolerance (Wells & Shunk 1931), does not grow well in continuously saturated soils but prefers better-drained and drier areas (Wahlenberg 1946; Shoulders 1983; see also Ware, Frost, & Doerr 1993). This generalization finds support in our earlier study of pine growth in bogs. In that study, we found that average tree ring width of longleaf pines in bogs was one-third that of longleaf in drier upland areas (MacRoberts & MacRoberts 1993). Our observation that the tallest trees in the bog occurred on slight rises also supports this idea.

Brown spot disease is associated with strong light (stimulating stomata opening) and high humidity, conditions that occur in bogs that often have standing water (Kais 1975). Because brown spot defoliates, it is a starvation disease resulting in decreased growth that generally persists in successive growing seasons and makes the tree more vulnerable to successive reinfestations (Wahlenberg 1946). If seedlings do not die as a direct result of unfavorable hydric conditions, debilitation increases vulnerability to disease. The prevalence of brown spot among grass stage individuals in Plot 1 supports this idea.

Fire also affects seedling growth and survival. Studies of grass and pre-grass stage longleaf pines have shown significant size effects on survival from fire, particularly fire intensity (temperature), which in turn is directly related to fuel load (Wahlenberg 1946; Grace & Platt 1995a, 1995b). Brown spot disease and the generally stressed condition of the plant increase foliage flammability and expose the growth bud, again reducing seedling survival. Also the tree remains in a vulnerable condition for a longer time.

The few longleaf pines that do survive in bogs (MacRoberts & MacRoberts 1993) probable do so because, while the species is adapted to a wide range of habitat conditions (Wells & Shunk 1931; Wahlenberg 1946; Platt, *et al.* 1988), it is one of the few woody species adapted to fire and can therefore survive however stressful the growing conditions may be (Streng, *et al.* 1993). Slight elevational differences within a bog may provide just enough difference in moisture to allow longleaf pine to survive. In the absence of fire, other woody species invade bogs.

While we have discussed several possible factors involved in keeping bogs open, in the present case fire is probably not a major factor. This bog has not been burned since 1994, and yet it is losing longleaf pines faster than the surrounding drier areas and the trees in the bog are growing much more slowly. Even without fire, there would be large differences between the density, and certainly in the size, of pines in bogs and in drier areas. With fire, we suspect that the difference would be intensified. Many of the longleaf pines in the bog are sickly and would undoubtedly be destroyed by fire.

Our observations suggest, then, that a combination of interrelated factors may keep bogs open: stress due to soil saturation, disease, and fire. Soil saturation retards growth causing increased mortality, but also increases vulnerability to fire and disease by prolonging the grass stage of development.

But our primary purpose here has not been to discover the underlying reasons why longleaf pines have different growth and survival rates in bogs and in drier areas, but rather to document that there is a difference, which aids in explaining why bogs are open communities.

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THE FLORISTICS OF CALCAREOUS PRAIRIES ON THE KISATCHIE NATIONAL FOREST, LOUISIANA.

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ABSTRACT

The floristics and edaphic factors of central Louisiana calcareous prairies are described. In presettlement times, prairies were fairly common and widely distributed in central and north Louisiana but because of anthropogenic disturbances only a few remnants remain.

KEY WORDS: Prairie, Kisatchie National Forest, floristics, Louisiana

INTRODUCTION

While the disappearance of prairies from the midwest over the past two centuries is well documented (Axelrod 1985; Smeins & Diamond 1986; Sims 1988; Kucera 1992; Smeins, *et al.* 1992), their occurrence in and disappearance from the southeastern United States is not well documented (DeSelm & Murdock 1993). In presettlement times there were numerous fairly large prairies scattered across northern and central Louisiana (Lockett 1969; Flores 1984; Smith, *et al.* 1989; Teague & Wendt 1994; MacRoberts & MacRoberts 1995a) but because of anthropogenic activities, these have almost vanished.

In Louisiana the community is ranked as critically imperiled (Smith, *et al.* 1989). Prairies provide critical refugia for many rare species, adding significantly to the diversity of the area.

Some of the most intact prairies in Louisiana occur on the Kisatchie National Forest, notably in the Winn Ranger District in Winn and Grant parishes (Smith, *et al.* 1989; MacRoberts & MacRoberts 1995b, 1996). These prairies represent the best chance for preserving this unique natural community in Louisiana.

In this paper we report on the floristics and edaphic factors of the prairies on the Winn District of the Kisatchie National Forest in Winn Parish.

METHODS

The Keiffer Prairies comprise a group of about 45 openings in calcareous forest extending approximately 14 km northeast and southwest of Calvin in eastern Winn Parish (Smith, *et al.* 1989; MacRoberts & MacRoberts 1996). The name comes from John Keiffer, an early settler, and is applied collectively to the entire group of prairies near Calvin. Located in T11N R4W Secs. 7, 8, 18; T11N R5W Secs. 13, 23-26, 35; T12N R4W Secs. 33-35, these prairie openings range in size from about 0.1 ha. to ten hectares. The largest prairie straddles Forest Service and private land. Collectively, the Keiffer Prairies total about 70 ha. (Smith, *et al.* 1989).

Five additional prairies occur in nearby northern Grant Parish and in southeastern Winn Parish. These we will refer to collectively as the Packton Prairies. These or closely associated prairies are probably the prairies originally described by Lockett (1969: 72) as Bertram's or Tancock's prairies. Three are in T9N R3W Secs. 2 and 10 (Winn Parish), and two are in T9N R2W Secs. 5 and 6 (Grant Parish). These five prairies range in size from about 0.2 ha. to 4.0 ha. The largest straddles Forest Service land. They total about 12 ha. (MacRoberts & MacRoberts 1996).

The prairies all have been heavily grazed in the past; a few have been farmed, at least for short periods (Smith, *et al.* 1989). Because of downed fences one of the prairies was still heavily grazed in 1996.

We selected two of the Keiffer Prairies (Milam Branch and Coldwater) as representative examples for a detailed floristic inventory and visited them every two to three weeks between the spring of 1996 and the fall of 1996. Milam Branch Prairie is one of the more northern of the Keiffer group and Coldwater is one of the more southern. They are about 6.5 km apart.

Milam Branch Prairies consists of two sections. We surveyed the smaller, western section (about 1.2 ha., T11N R4W Sec. 7). Coldwater Prairie also consists of two sections. We surveyed the smaller southern section (ca. 1.6 ha., T11N R5W Sec. 26). The study sites are about 70 meters above sea level.

During these visits we collected or recorded all vascular plants encountered and took soil samples for analysis.

We had visited these and other Keiffer Prairies regularly since 1994, notably as part of a survey for rare plant species on the Kisatchie National Forest (MacRoberts & MacRoberts 1995b), and we were familiar with the entire group when the 1996 survey began. In the late 1980's the Louisiana Natural Heritage Program made the first preliminary survey of the Keiffer prairies and visited some of them (Smith, *et al.* 1989).

In 1996 we visited every prairie to check on their condition (woody encroachment, ground disturbance) and to make brief floristic surveys (MacRoberts & MacRoberts 1996). Because a number of plants are fidel to prairies and therefore are very rare in Louisiana, a special effort was made to look for rare species.

Prairies have a distinctive signature on aerial photographs. Consequently, aerial photographs and previous survey maps made locating prairies easy.

Annual precipitation averages about 125 cm and is fairly evenly distributed throughout the year. In summer, temperatures rise to 35° C; this, combined with short droughts, translates into very hot and dry conditions especially in open areas.

Under drought conditions the calcareous soils tend to dry, forming wide cracks. When wet, these soils are very sticky. In all the prairies we have examined, small calcareous concretations are common.

Voucher specimens are deposited in VDB, SFRP, LSU, LSUS, NLU, and BRCH. Nomenclature mostly follows Kartesz (1994).

Soil samples taken from the upper 15 cm of the prairies were analyzed by A. & L. Laboratories, Memphis, Tennessee.

RESULTS

Table 1 lists the vascular plants found in Milam Branch and Coldwater prairies. The letter "M" following the species indicates presence at Milam Branch, "C" indicates presence at Coldwater, and no letter presence at both prairies.

Table 2 gives information on the soil characteristics of Milam and Coldwater prairies.

These rather neutral soils are high in calcium and very low in other nutrients. Further information on prairie soils is given in our previous paper (MacRoberts & MacRoberts 1995a; see also Smith, *et al.* 1989).

DISCUSSION

We recorded 137 species, representing 107 genera and 44 families for the two prairies. Milam Branch had 100 species, 82 genera, and 39 families. Coldwater had 124 species, 99 genera, and 41 families. This makes these prairies as species rich as other similar sized plant communities in the region, for example, bogs (MacRoberts & MacRoberts 1993). Grasses, composites, and legumes dominate, making up 46% of the species total. Sorensen's Index of Similarity indicates that Milam and Coldwater prairies are vegetationally the same (IS = 78).

Table 1. Vascular plants at two prairies.

ACANTHACEAE - *Ruellia humilus* Nutt.

AGAVACEAE - *Manfreda virginica* (L.) Salisb. *ex* Rose.

ANACARDIACEAE - *Rhus copallinum* L., *Toxicodendron radicans* (L.) Kuntze.

ANNONACEAE -- *Asimina triloba* (L.) Dunal.

APIACEAE - *Eryngium yuccifolium* Michx. (C), *Polytaenia nuttallii* DC. (C), *Zizia aurea* (L.) Koch (C).

AQUIFOLIACEAE - *Ilex decidua* Walt., *I. vomitoria* Ait.

ASCLEPIADACEAE - *Asclepias tuberosa* L., *A. viridiflora* Raf., *A. viridis* Walt. (M).

ASTERACEAE - *Ambrosia psilostachya* DC., *Aster dumosus* L., *Aster oolentangiensis* Riddell, *Aster patens* Ait., *Aster sericeus* Vent., *Cacalia plantaginea* (Raf.) Shinners, *Cirsium horridulum* Michx., *Coreopsis lanceolata* L., *Echinacea pallida* (Nutt.) Nutt., *Erigeron strigosus* Muhl. *ex* Willd., *Eupatorium coelestinum* L., *Eupatorium semiserratum* DC. (C), *Gaillardia aestivalis* (Walt.) H. Rock., *Gnaphalium obtusifolium* L. (C), *Helenium autumnale* L., *Helianthus angustifolius* L. (M), *Helianthus hirsutus* Raf., *Iva annua* L. (C), *Liatris pycnostachya* Michx. (C), *L. squarrulosa* Michx. (C), *Rudbeckia hirta* L., *R. subtomentosa* Pursh. (C), *Silphium laciniatum* L., *S. radula* Nutt. (C), *Solidago canadensis* L., *Solidago nitida* Torrey & A. Gray, *Solidago rigida* L. (C), *Vernonia missurica* Raf. (C).

BORAGINACEAE - *Heliotropium tenellum* (Nutt.) Torr., *Onosmodium hispidissimum* Mackenzie (C).

CAMPANULACEAE - *Lobelia appendiculata* A. DC., *Triodanis perfoliata* (L.) Nieuwl. (M).

CAPRIFOLIACEAE - *Lonicera japonica* Thumb. (M), *L. sempervirens* L. (M), *Viburnum rufidulum* Raf. (C).

CORNACEAE - *Cornus drummondii* C.M. Mey., *C. florida* L.

CUPRESSACEAE - *Juniperus virginiana* L.

CUSCUTACEAE - *Cuscuta cuspidata* Engelm.

CYPERACEAE - *Carex microdonta* Torrey & Hook., *Fimbristylis puberula* (Michx.) Vahl.

Table 1 (cont.)

EBENACEAE - *Diospyros virginiana* L.

EUPHORBIACEAE - *Chamaesyce nutans* (Lag.) Small (M), *Euphorbia bicolor* Engelm. & A. Gray (M).

FABACEAE - *Baptisia alba* (L.) Vent., *Cercis canadensis* L. (C), *Dalea candida* Willd., *Dalea purpurea* Vent., *Desmanthus illinoensis* (Michx.) MacM. *ex* B.L. Robins. & Fern. (C), *Galactia volubilis* (L.) Britt. (C), *Gleditsia triacanthos* L., *Mimosa strigillosa* Torrey & A. Gray (C), *Neptunia lutea* (Leavenworth) Benth.

GENTIANACEAE - *Sabatia angularis* (L.) Pursh (C), *S. campestris* Nutt.

HAMAMELIDACEAE - *Liquidambar styraciflua* L.

IRIDACEAE - *Nemastylis geminiflora* Nutt. (C), *Sisyrinchium campestre* Bickn.

LAMIACEAE - *Monarda fistulosa* L. (C), *Prunella vulgaris* L., *Pycnanthemum tenuifolium* Schrad., *Salvia azurea* Michx. *ex* Lam., *Salvia lyrata* L., *Scutellaria parvula* Michx. (C).

LILIACEAE - *Allium canadense* L., *Hypoxis hirsuta* (L.) Coville, *Nothoscordum bivalve* (L.) Britt., *Smilax bona-nox* L.

LINACEAE - *Linum sulcatum* Riddell.

LOGANIACEAE - *Cynoctonum mitreola* (L.) Britt. (M)

MALVACEAE - *Callirhoe papaver* (Cav.) A. Gray.

ONAGRACEAE - *Gaura longiflora* Spach.

ORCHIDACEAE - *Spiranthes magnicamporum* Sheviak.

PINACEAE - *Pinus echinata* P. Mill., *P. taeda* L.

PLANTAGINACEAE - *Plantago virginica* L. (C).

POACEAE - *Andropogon gerardii* Vitman (C), *Andropogon glomeratus* (Walt.) B.S.P., *Aristida longespica* Poir., *Aristida oligantha* Michx., *Aristida purpurascens* Poir., *Dichanthelium aciculare* (Desv. *ex* Poir) Gould & C.A. Clark (C), *Eragrostis spectabilis* (Pursh) Steud., *Muhlenbergia capillaris* (Lam.) Trin., *Panicum anceps* Michx., *P. virgatum* L. (C), *Paspalum floridanum* Michx., *P. setaceum* Michx., *Schizachyrium scoparium* (Michx.) Nash, *Setaria geniculata* Beauv., *Sorghastrum nutans* (L.) Nash, *Sphenopholis obtusata* (Michx.) Scribn. (C), *Sporobolus asper* (Michx.) Kunth (C), *S. junceus* (Beauv.) Knuth, *Tridens flavus* (L.) Hitchc. (C), *T. strictus* (Nutt.) Nash (M).

Table 1 (cont.)

POLEMONIACEAE - *Phlox pilosa* L. (C).

PRIMULACEAE - *Lysimachia lanceolata* Walt.

RANUNCULACEAE - *Delphiniun carolinianum* Walt., *Ranunculus sardous* Crantz.

RHAMNACEAE - *Berchemia scandens* (Hill) K. Koch, *Ceanothus americanus* L. (C).

ROSACEAE - *Agrimonia microcarpa* Wallr. (C), *Crataegus berberifolia* Torrey & A. Gray (C), *C. marshallii* Egglest. (C), *C. spathulata* Michx. (C), *Rubus* sp.

RUBIACEAE - *Diodia teres* Walt. (M), *D. virginiana* L. (M), *Hedyotis nigricans* (Lam.) Fosberg, *Houstonia purpurea* L. var. *calycosa* A. Gray.

SAPOTACEAE - *Bumelia lanuginosa* (Michx.) Pers.

SCROPHULARIACEAE - *Agalinis oligophylla* Pennell (M), *Buchnera americana* L. (C), *Gratiola neglecta* Torr., *Pedicularis canadensis* L., *Penstemon australis* Small, *Penstemon tubaeflorus* Nutt.

SOLANACEAE - *Solanum carolinense* L. (M)

ULMACEAE - *Ulmus alata* Michx.

VALERIANACEAE - *Valerianella radiata* (L.) Dufr.

VERBENACEAE - *Glandularia canadensis* (L.) Nutt., *Verbena brasiliensis* Vell.

VITACEAE - *Ampelopsis arborea* (L.) Koehne (C)

Table 2. Soil characteristics of Milam and Coldwater prairies.

		Exchangeable Ions (ppm)				
Sample	pH	P	K	Ca	Mg	OM%
Coldwater	7.4	1	91	3980	73	3.2
Milam	7.3	2	132	4990	84	4.1

These prairies have their greatest resemblance to the tallgrass prairies of the midwest and to the blackland prairies of Arkansas, east Texas, Mississippi, and Alabama (Smith, *et al.* 1989; Smeins, *et al.* 1992; Smeins & Diamond 1986).

As part of this project, we visited every prairie opening during 1996. On these visits we noted details of floristics, rare species, and prairie condition. Almost without exception, all had surface damage ranging from fire lines to roads through them, some still in use and others with old logging roads. The major threat appears to be encroachment of eastern red cedar and other woody species into the prairies due to fire suppression. We also noted severe detritus buildup, which will ultimately shade out the smaller herbaceous species. This latter point should be emphasized. It is well known that detritus accumulation limits productivity of tallgrass prairies. While a prairie may look healthy because it has impressive stands of big bluestem, it may in fact be losing species diversity because of dense detritus accumulation close to the ground (Knapp & Seastedt 1986).

RARE SPECIES

The Louisiana Natural Heritage rare or watch lists (Louisiana Natural Heritage Program 1995) include fifteen prairie species occurring in the Keiffer and Packton prairies. These prairies have been botanized since the late 1930's, intensively so after the 1980's (Smith, *et al.* 1989). In this section we summarize the distribution of the species on the Louisiana Natural Heritage Plant List (LNHP) in the Keiffer and Packton prairies.

We will not repeat information contained in our previous paper on rare Kisatchie National Forest plants (MacRoberts & MacRoberts 1995b). That publication should be consulted for further information on each species, notably voucher specimens and precise locations.

Detailed maps of prairie species locations are on file with the Kisatchie National Forest (MacRoberts & MacRoberts 1996). We have no additional information on the following species: *Asclepias stenophylla* A. Gray., *Astragalus crassicarpus* Nutt., *Carex meadii* Dewey, *Ceanothus herbaceus* Raf., *Euphorbia bicolor* Engelm & A. Gray, *Koeleria macrantha* (Lebed.) J.A. Schultes, *Panicum flexile* (Gatt.) Scribn., *Polygala verticillata* L., *Polytaenia nuttallii* DC., and *Sporobolus ozarkanus* Fernald (MacRoberts & MacRoberts 1995b).

Asclepias viridiflora Raf. We have now recorded green milkweed -- LNHP watch list species -- for most of the Keiffer and Packton prairies. It probably occurs at least in all the larger ones. While frequently present, it is never common, often just a few individuals occurring in a prairie

Carex microdonta Torrey & Hook. Small- toothed sedge forms a major component of the herbaceous layer in all the Keiffer and Packton prairies.

Heliotropium tenellum (Nutt.) Torrey. Slender heliotrope occurs in almost all the Packton and Keiffer prairies, but for some reason is found in the central Keiffer prairies and not in the southern and northern ones.

Houstonia purpurea L. var. *calycosa* A. Gray. Purple bluet is found in almost all the Keiffer and Packton prairies.

Spiranthes magnicamporum Sheviak. (*MacRoberts & MacRoberts 2961* [LSU], *2963* [NYS], *2964* [LSUS], *2965* [SFRP], *2966* [DAO], *2967* [VDB]). Great Plains ladies-tresses was first found in the Keiffer prairies in 1995 (T11N R4W Secs. 7-8, T11N R5W Secs. 25-26, T11N R5W Sec. 35). Spot checks that winter located it in three Keiffer prairies but failed to locate it in the Packton prairies. The only other known Louisiana location for this species is a single site in Ouachita Parish (Louisiana Natural Heritage Program 1995). In October and November 1996, we located it in two additional Keiffer prairies (both in T11N R5W Sec. 24).

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COMMENTS ON THE "*COREOCARPUS ARIZONICUS-C. SONORANUS* (ASTERACEAE, HELIANTHEAE) COMPLEX"

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ABSTRACT

A recent paper on *Coreocarpus* by B.L. Turner proposed nomenclatural changes in the genus. This note offers comments on the changes.

KEY WORDS: Asteraceae, Heliantheae, *Coreocarpus*, systematics

Turner (1996) recently reviewed "the *Coreocarpus arizonicus-C. sonoranus* complex." In that paper, he reduced *C. sanpedroensis* E.B. Smith to a variety of *C. arizonicus* (A. Gray) S.F. Blake and proposed a new variety, var. *libranus*, in *C. sonoranus* Sherff.

Coreocarpus sanpedroensis is a member of what I called the *C. sonoranus* complex (Smith 1989). That complex included several forms of *C. sonoranus*, several varieties of *C. parthenioides*, and *C. sanpedroensis*.

In artificial hybridizations that I performed (see Table 1 in Smith 1989), *Coreocarpus sanpedroensis* crossed successfully with *C. sonoranus* and *C. parthenioides*; but *C. sonoranus* and *C. parthenioides* would NOT cross in these studies with *C. arizonicus*. While I was not able to attempt the cross *C. sanpedroensis* × *C. arizonicus* (the two did not flower at the same time during my greenhouse study), it is likely that the cross would have failed. This is significant biosystematic information, which Turner (1996) apparently ignored. In addition, *C. sanpedroensis* and *C. sonoranus* both have the achene wing corky, involute, and dissected into separate teeth, whereas *C. arizonicus* has the achene wing thin, spreading, and not dissected into separate teeth (see key, and Figure 1 in Smith 1989). The relationship of *C. sanpedroensis* falls with the *sonoranus* complex, NOT with *C. arizonicus* as treated by Turner (1996). I consider the combination *C. arizonicus* (A. Gray) S.F. Blake var. *sanpedroensis* (E.B. Smith) B.L. Turner a synonym of *C. sanpedroensis* E.B. Smith.

Turner (1996) named one segregant of *Coreocarpus sonoranus* as a new variety [var. *libranus* B.L. Turner]. As I mentioned (Smith 1989), the forms of *C. sonoranus* vary from population to population in an "island variant" pattern. One population will be glabrous, white-flowered, with exaristate achenes, the next will be pubescent, white-flowered, with aristate achenes; the next pubescent, pale yellow-flowered, with exaristate achenes, and so on. The individual populations are more or less uniform, tempting one to recognize varieties.

I raised live plants from achenes of *Van Devender 84-36* (the holotype for Turner's var. *libranus*!), and collected in La Pintada Canyon myself (*Smith 3972* [TEX, UARK]). At first glance, the La Pintada Canyon population looks like a new variety (or even a new species). But, with further study of a wider series of collections of *C. sonoranus*, it becomes clear that the various populations are "island variants." If one of these variant populations is named a variety, should they each receive a name? Despite Tom Van Devender's proddings, I prefer treating the species as consisting of a series of forms, and not recognizing the populations with formal varietal epithets. I would synonymize var. *libranus* under *C. sonoranus*.

In summary, I do not see a "*Coreocarpus arizonicus-C. sonoranus* complex" in the genus, but a *C. arizonicus* complex and a *C. sonoranus* complex. *Coreocarpus sanpedroensis* belongs in the latter, not the former. I prefer not to recognize a series of varieties in *C. sonoranus*, which Turner's var. *libranus* suggests.

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EPIDERMIS EN LAMINAS FOLIARES DEL GENERO *BOUTELOUA* LAGASCA, (POACEAE: CHLORIDOIDEAE) DE MEXICO

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RESUMEN

Se llevó a cabo el estudio comparativo de la anatomía de la epidermis abaxial en láminas foliares de 34 especies y doce variedades del género *Bouteloua* de México. Once caracteres cruciales se sometieron a un análisis fenético del que resultaron tres grupos principales. Con base en la anatomía de epidermis foliar se llega a una conclusión significativa, que el género *Bouteloua* no debiera ser dividido en dos géneros: *Bouteloua* Lag. y *Chondrosum* Desv.

PALABRAS CLAVE: Epidermis, *Bouteloua*, Poaceae, anatomía

ABSTRACT

An anatomical study of the abaxial epidermis in leaves of 34 species and twelve varieties of *Bouteloua* from México was done. Eleven key characters found were submitted to a phenetic analysis, where three main groups resulted. A significant conclusion reached is that *Bouteloua* should remain as a genus, with no division into: *Bouteloua* Lag. and *Chondrosum* Desv. at a generic level, based on leaf epidermal anatomy.

KEY WORDS: Epidermis, *Bouteloua*, Poaceae, anatomy

INTRODUCCION

De las gramíneas con mayor importancia económica para México por su alto valor forrajero, amplia distribución y adaptabilidad es el género *Bouteloua* que comprende aproximadamente 50 taxa en México. Las principales contribuciones al conocimiento taxonómico del género son los estudios realizados por: Griffiths (1912) y Gould (1979).

Durante los pasados 50 años el uso de nuevos criterios, anatómicos, morfológicos, y citológicos han sido muy significativos en la separación de las gramíneas dentro de seis subfamilias distintas. En el presente algunas de las nuevas características más comúnmente usadas son concernientes a los tipos de células epidérmicas de las hojas (Ebinger & Carlen 1975). Estudios de la epidérmis de hojas en gramíneas, han sido muy escasos a la fecha; se han realizado en otros grupos y en géneros relacionados pero no se ha reportado ninguno para el género *Bouteloua*.

Los datos generados en el presente trabajo son una contribución al programa "Estudio biosistemático de las gramíneas de importancia forrajera en México" que se lleva a cabo en el CIIDIR IPN Unidad Durango, en colaboración con el Herbario de la Universidad Autónoma de Aguascalientes.

MATERIALES Y METODOS

Los especímenes que se utilizaron en este proyecto fueron tomadas de dos fuentes 1) colecta de campo a nivel nacional, que se llevaron a cabo en las localidades de distribución natural de cada taxa, por el grupo de colaboradores del proyecto (CIIDIR-HUAA); 2) Ejemplares de herbario (ANSM,CIIDIR,ENCB,HUAA,IEB,IBUG, MEXU,SLPM, y UAG), con el fin de complementar el estudio de especies no encontradas en el campo.

Para la obtención de los cortes longitudinales se utilizó la técnica de raspado directo con el cual se obtienen fragmentos de muestra largas, donde se pueden observar los caracteres mas fácilmente. Se seleccionaron al menos dos láminas foliares de las mejor desarrolladas que presentara el ejemplar, de ellas se corta el tercio medio, se hirven en agua con detergente comercial durante 30 minutos, para hidratar y ablandar los tejidos. Se procede en seguida a raspar con navaja bisturí sobre el lado adaxial; un buen raspado se hace observando bajo el estereomicroscopio, con el fin de separar las células de la epidermis adaxial y el mesófilo, y lograr aislar la epidermis abaxial. Se tiñen los cortes epidérmicos en safranina concentrada, posteriormente se pasan por alcohol a diferentes concentraciones (30%, 50%, 70%, y 96%) para eliminar el exceso de agua. Se montan las muestras en resina, haciendo de 2 a 4 laminillas por ejemplar. En algunas especies que era difícil diferenciar estructuras se utilizó el verde rápido además de la safranina para que tomaran diferentes tonalidades y de esta manera obtener mejores descripciones.

Las observaciones anatómicas fueron realizadas con microscopio compuesto, a 10× y 40×. Contabilizando el número de zonas costales e intercostales de cada

especie, el número de hileras de células por zona, las combinaciones de células largas-células cortas, la forma de los cuerpos de sílice, forma de los ganchos, etc. Se tomaron microfotografías de cada una de las especies con un microscopio óptico a 40× y 10× (las microfotografías tomadas a 10× solo se tomaron cuando era necesario señalar alguna característica distintiva de una especie o de un grupo de especies). Se tomaron medidas de los componentes epidérmicos por medio de un micrómetro ocular colocado en el microscopio compuesto con un ocular de 10× y un objetivo de 40×. Para hacer las descripciones se siguió el manual de Ellis, "A procedure for standardizing comparative leaf anatomy in the Poaceae: II The epidermis as seen in surface view". (Ellis 1979).

Once caracteres epidérmicos clave (Cuadro 2) de las 34 especies y doce variedades analizadas (Cuadro 1) fueron utilizadas para hacer una matriz de caracteres (Cuadro 3) que se sometió a un análisis de similitudes utilizando el programa "Multivariate Statistical Package" (versión 1.31; Kovach 1987) para generar el dendrograma, aplicando el Indice de Euclidean Normalizado, para generar la matriz de similitudes, a partir de la cual se construyo el árbol de similitudes o dendrograma mediante la utilización de UPGMA (Unweighted pair group mathematical average clustering analysis).

RESULTADOS

Las hojas de las gramíneas están constituidas de vaina y lámina foliar, éstas en corte transversal presentan epidérmis, mesófilo y sistema vascular; el presente estudio se realizó en la epidermis abaxial de la lámina foliar que consta de venas o bandas longitudinales denominadas zona intercostal (entre las venas) y zona costal (sobre las venas), ambas zonas se componen de dos tipos de células: las células largas y las células cortas, las segundas reciben dos nombres dependiendo del contenido, unas son llamadas células de sílice cuando su interior esta lleno de SiO_2 recibiendo el nombre de cuerpos de sílice, las otras células de corcho, se denominan así por presentar sus membranas suberificadas. Los cuerpos de sílice toman diferentes forma de acuerdo a la especie.

Las 34 especies y doce variedades del género *Bouteloua* de México, revisadas en este trabajo (Cuadro 1), presentan la descripción general de la epidermis abaxial de láminas foliares que se describe a continuación.

Bouteloua Lagasca (POACEAE; CHLORIDOIDEAE)
ZONA COSTAL.- Células costales largas (3-)20-120 μ de longitud, 3× o más largas que anchas, 2-8 μ de ancho, paredes horizontales paralelas, células rectangulares, paredes verticales de los extremos inclinadas o en ángulo recto con respecto a las paredes horizontales, paredes horizontales y verticales delgadas o engrosadas con o sin bandas cuticulares presentes. Ondulaciones de las paredes horizontales sinuosas, sinuosidades de 1-2 μ de profundidad, en forma de Ω algunas veces en forma de U. Células costales cortas: células de silice-corcho alternas o formando triadas de células de silice-células de corcho-células largas en una fila, células de corcho de corma

cuadrada a corto rectangulares. Cuerpos de sílice de forma redondeada a circular formando una doble equis, de 3-7 μ en lado vertical y de 3-8 μ en el lado horizontal. Ganchos: cerdas de base más corta, igual o más larga que el estoma, barba pequeña o igual que la base, barba curva o recta, en dirección al ápice de la lamina, se distribuyen en toda la zona costal o en los extremos.

ZONA INTERCOSTAL.- Células intercostales largas, 10-65(-70) μ de longitud, 3× más largas que anchas, (2-)3-11 μ de ancho, paredes laterales horizontales paralelas unas con respecto a otras, células rectangulares algunas veces cuadradas, paredes verticales de los extremos inclinadas o en ángulo recto en relación a las paredes horizontales, paredes verticales y horizontales delgadas algunas veces con bandas cuticulares presentes, ondulaciones de las paredes horizontales sinuosas, profundidad de las sinuosidades aproximadamente de 1-2(-3) μ en forma de Ω. Células intercostales cortas en pares o solitarias, altas y angostas con márgenes lisos, crenados, o irregulares. Estomas: en forma de domo bajo, células redondeadas, ovoides, ancho vertical de las células subsidiarias más pequeño que el lado vertical, se distribuyen en dos hileras por zona intercostal algunas veces una sola hilera de estomas por zona intercostal; en las zonas intercostales de los extremos adyacentes a los márgenes de la hoja sepresenta una sola hilera de estomas, células interestomatales entre estomas sucesivos, con los extremos cóncavos. Micropelos, bicelulares, célula basal más larga que la célula distal, pared de la célula distal más delgada que la pared de la célula basal, con frecuencia caediza, emergen de la superficie de la célula corta formando un ángulo recto o sin formar dicho ángulo, se distribuyen entre o fuera de las hileras de estomas. Macropelos unicelulares. Papilas presentes por lo general en los extremos de las células intercostales largas y en las células interestomatales.

<u>En la Zona Costal encontramos que:</u>

Las especies del género *Bouteloua* presentan células largas de gran tamaño hasta 110 μ de longitud, son angostas con los lados horizontales paralelos y sinuosos.

Las células de sílice presentan cuerpos de sílice de la misma forma, con pocas variaciones en tamaño, quedando dentro de un rango de 3-10 μ en el lado vertical y 3-9 μ en el lado horizontal de todas las especies, Metcalf (1960) los encuentra con forma de silla de montar nombrados por Ellis (1979) como una doble equis. Esta característica de la forma de los cuerpos permitió definir con claridad las especies pertenecientes al género *Bouteloua* y puede constituir un caracter clave en la delimitación del género, de gran utilidad, por ejemplo cuando al revisar ejemplares no se tenga seguridad de la especie determinada por caracteres morfológicos, así como en el caso de las colectas de material que no tengan completas sus estructuras morfológicas. Las células de corcho (suber) son de forma cuadrada a corto-rectangulares con los márgenes horizontales en ocasiones crenados u ondulados.

Como se mencionó anteriormente las zonas costales se componen de filas horizontales de: 1) células largas, 2) células largas - células cortas, dependiendo del segundo tipo se distinguen las siguientes combinaciones, en sentido horizontal:

CUADRO 1. Especies de *Bouteloua* analizadas para este estudio.

1. *Bouteloua alamosana* Vasey. Oaxaca: 92 miles of Oaxaca, mpio. Oaxaca de Juárez, 14 XI 65, *F.W. Gould 11661* (ENCB).
2. *Bouteloua americana* (L.) Scribner. Yucatán: Carretera a Ocum, 2 km al S de Mérida, 8m, 15 X 82, *J.S. Flores, C. Chan, & M. Burgos 9563* (ENCB).
3. *Bouteloua annua* Swallen. Baja California: Gulf of California, isle San Esteban, 22 III 62, *L.W. Wiggins 17212* (ENCB).
4. *Bouteloua aristidoides* (Kunth) Griseb. var. *aristidoides*. Coahuila: 5.5 km al NW de Nva. Delicias, Vertiente E de la Sierra Delicias, 1230 m, *Herrera y col. 1489*, (CIIDIR-HUAA). Colima: Km 11 Autopista 110 Colima-Manzanillo, 2 km de los Amoles, *Herrera y Cortés 1467* (CIIDIR-HUAA). Jalisco: 14 km de Tonaya rumbo al Gruyo, 1080 m, *Herrera, Esparza, & Rosales 1476* (CIIDIR-HUAA).
5. *Bouteloua barbata* Lagasca var. *barbata*. Sonora: km 24 Autopista #15 Hermosillo - Nogales lado E de la carretera, 400 m, 25 XI 94, *Herrera & Siqueiros 1322* (CIIDIR-HUAA); Km 126 Autopista #15 Hermosillo-Nogales, 780 m, 25 XI 94, *Herrera & Siquieros 1328* (CIIDIR-HUAA); Km 132 Autopista Hermosillo - Nogales, 770 m, 25 XI 94, *Herrera & Siqueiros 1330* (CIIDIR-HUAA).
6. *Bouteloua barbata* Lagasca var. *rothrockii* Vasey. Sinaloa: ± 46 km al W de Culiacán, por la carretera al Tate frente al ejido La Bandera, y 2 km al W de Valdés Montoya orilla de carretera, 90 m, 21 XI 94, *Herrera & Siqueiros 1316* (CIIDIR-HUAA).
7. *Bouteloua barbata* Lagasca var. *sonorae* (Griffiths) Gould. Sinaloa: Culiacan, Cajón Río Pioxtla, San Ignacio, carretera Mazatlán - Culiacán, en el cruce del Río Pioxtla, 130 m, 20 XI 94, *Herrera & Siqueiros 1309* (CIIDIR-HUAA).
8. *Bouteloua breviseta* Vasey. Coahuila: Sierra de Parras, Parras, 1850 m, 29 IX 78, *M.A. Copo & J. Valdés 1354* (ANSM); 2 km al N de Cañada Blanca, km 17 carr. 57 Saltillo-Monclova, 1800 m, 4 X 95, *Herrera y col. 1479, 1481* (CIIDIR-HUAA).
9. *Bouteloua chasei* Swallen. Coahuila: 40 km al SW de Saltillo, rumbo a Zacatecas, en el km 295 de la carretera 54, 19 XII 94, *Herrera y Cortés 1457* (CIIDIR). Nuevo León: 8 km al entronque de San Roberto, rumbo a Galeana, mpio. Galeana, 17 XII 94, *Herrera & Cortés 1449* (CIIDIR). San Luis Potosí: Km 145 carr. 57 S.L.P. - Matehuala, 8 km sobre desviación a Guadalcazar, 1800 m, 26 XI 94, *Herrera & Cortés 1446* (CIIDIR).
10. *Bouteloua chondrosioides* (Kunth) Benth *ex* S. Watson. Durango: Km 5.5 carr. Santiago Papasquiaro - Los Altares, 2000 m, 6 X 90, *A. Benitez 2731* (CIIDIR).
11. *Bouteloua curtipendula* (Michaux) Torrey. Coahuila: 2 km al N de Cañada Blanca, km 17 carr. 57 Saltillo-Monclova, 1800 m, 4 X 95, *Herrera y col. 1481* (CIIDIR-HUAA). Durango: Rancho Tarahumara, Agua Blanca, *Canatlán, Herrera, & González 1019* (CIIDIR).
12. *Bouteloua curtipendula* (Michaux) Torrey var. *caespitosa* Gould & Kapadia. Aguascalientes: Km 12 carretera Aguascalientes - Calvillo, al N del cerro el Picacho, 1900 m, 8 XII 94, *Herrera & Cortés 1384* (CIIDIR-HUAA).
13. *Bouteloua curtipendula* (Michaux) Torrey var. *tenuis* Gould & Kapadia. Durango: 1 km al W de Tepehuanes, *Bravo 200* (CIIDIR).
14. *Bouteloua distans* Swallen. Puebla: 12 miles NNW of Huajapan de León, Oaxaca, along Hwy. 190, 17° 56′ 35″ N, 97° 52′ 34″ W, *Columbus 2403* (RSA, HUAA cultivada).

CUADRO 1 (cont.).

15. *Bouteloua distica* (Kunth) Benth. Guanajuato: 10 miles E of El Gruyo, 2 mi W of San Miguel, 915 m, 27 IX 74, *R. Reeder 6381* (ENCB).
16. *Bouteloua elata* Reeder & Reeder. Colima: Km 17 Autopista 110 Colima-Manzanillo, Col. 1440 m, 5 II 95, *Herrera & Cortés 1466* (CIIDIR). Jalisco: ± 8 km al N de Autlán de Navarro sobre la carr. Federal # 80, Autlán de Navarro, 1000 m, 4 II 95, *Herrera & Cortés 1462* (CIIDIR-HUAA).
17. *Bouteloua eludens* Griffiths. Sonora: 3 km al S de Nogales, por autopista a Hermosillo, mpio. Nogales, 1300 m, 24 XI 94, *Herrera & Siqueiros 1336* (CIIDIR-HUAA).
18. *Bouteloua eriopoda* (Torrey) Torrey. Chihuahua: Rancho Experimental La Campana, *Herrera & Siqueiros 1340* (CIIDIR-HUAA). Coahuila: Universidad Autónoma Agraria Antonio Narro, Saltillo, *H. García s/n* (ENCB,SLPM).
19. *Bouteloua eriostachya* (Swallen) Reeder. Coahuila: 5.5 km al NW de Nva. Delicias, Vertiente E de la Sierra de las Delicias, 1230 m, 4 X 95, *Herrera y col 1491* (CIIDIR-HUAA).
20. *Bouteloua gracilis* (Kunth) Lagasca *ex* Griffiths. Aguascalientes: Universidad Autónoma de Aguascalientes, 1880 m, Octubre de 1995, *Rosales s/n* (HUAA); 5 km al N del poblado Gracias a Dios, J. María, 2050 m, 14 XI 94, *Herrera y col. 1306* (CIIDIR-HUAA). Durango: 66 km al W de Bermejillo y 22 km al W de Mapimí rumbo a la Zarca, 1800 m, 26 XI 94, *Herrera 1346* (CIIDIR).
21. *Bouteloua hirsuta* Lagasca var. *glandulosa* (Cerv.) Gould. Zacatecas: 40 miles N of Guadalajara, in Mex. 41, 1800 m, 25 VIII 70, *L.H. Harvey 8703* (ENCB).
22. *Bouteloua hirsuta* Lagasca var. *hirsuta*. Aguascalientes: 8 km antes de San Antonio de los Ríos, Sn. J. Gracia, 2100 m, 24 IX 80, *De la Cerda 385A* (HUAA). Chihuahua: Rancho La Campana, potreros del lado W, 1590 m, 25 XI 94, *Herrera & Siqueiros 1341* (CIIDIR-HUAA).
23. *Bouteloua johnstonii* Swallen. Coahuila: Sierra de la Paila, Valle de Parreña, Mpio, Gral. Cepeda, 2000 m, 31 X 87, *J.A. Villarreal 4173* (IEB).
24. *Bouteloua karwinskii* (Fournier) Griffiths. Coahuila: Km 45 carr. 40 Saltillo-Torreón, 1 km al N del ejido La Rosa, 1600 m, 4 X 95, *Herrera y col. 1478* (CIIDIR-HUAA). San Luis Potosí: 3 km al SW de San Lorenzo, Mpio. Villa Hidalgo, 1450 m, 27 VIII 59, *Rzedowski 11460* (ENCB).
25. *Bouteloua media* (Fournier) Gould & Kapadia. Puebla: 12 km W of Izucar de Matamoros, along Hwy. 57, near km 74, 19° 56′ 20″ N, 99° 21′ 40″ W, *Columbus 2632* (RSA,HUAA cultivada).
26. *Bouteloua parryi* (Fournier) Griffiths var. *gentryi* (Gould) Gould. Durango: Río Nazas, margénes arenosos, km 175 de Dgo. a Parral, Mpio. Rodeo, Dgo. 1550 m, 26 XI 94, *Herrera & Siqueiros 1350* (CIIDIR-HUAA). Sinaloa: 21 km al S de Culiacán, frente al entronque de la presa Vivorilla a orilla de carretera, Mpio. Culiacán, 230 m, 21 XI 94, *Herrera & Siqueiros 1315* (CIIDIR-HUAA); 86 km de Culiacán a Guasave al W de la autopista sobre una terracería, 130 m, 21 XI 94, *Herrera & Siqueiros 1317* (CIIDIR-HUAA).
27. *Bouteloua parryi* (Fournier) Griffiths var. *parryi*. Colima: Ejido Madrigal, Mpio. Tecomán, *Flores 123* (IEB).

CUADRO 1 (cont.).

28. *Bouteloua pedicellata* Swallen. Guanajuato: 6 km al W de Pozos, sobre el camino a la autopista de Gto., 2300 m, 10 IX 87, *J. Rzedowski 44714* (IEB). Puebla: near Puebla-Tlaxcala border, 8 km SW of El Carmen (Tequixquitla) along Hwy. 129, 19° 17' 18" N, 97° 42' 41" W, *Columbus 2634* (RSA,HUAA cultivada).
29. *Bouteloua quiriegoensis* Beetle. Sonora: 10 km al SE de Alamos, 330 m, 22 XI 94, *Herrera & Siqueiros 1320* (CIIDIR-HUAA).
30. *Bouteloua radicosa* (Fournier) Griffiths. Aguascalientes: 5 km al N del poblado Gracias a Dios, km 1 al S de la Hacienda La Boveda, Jesús María, 2050 m, 14 XI 94, *Herrera y col. 1300* (CIIDIR-HUAA).
31. *Bouteloua reflexa* Swallen. Sinaloa: 15 km al S de Culiacán, sobre la carr. federal Mazatlán-Culiacán, 180 m, 20 XI 94, *Herrera & Siqueiros 1311* (CIIDIR-HUAA).
32. *Bouteloua repens* (Kunth) Scribner & Merrill. Aguascalientes: *Esparza 53* (HUAA). Jalisco: 5 km al W de Tecolotlán camino a Tenamaxtlán, 1580 m, 7 IX 95, *Herrera, Rosales, & Esparza 1474* (CIIDIR-HUAA). Sonora: 3 km al S de Nogales, autopista a Hermosillo, 1300 m, 24 XI 94, *Herrera & Siqueiros 1339* (CIIDIR-HUAA).
33. *Bouteloua rigidiseta* (Steudel) Hitchcock. *Columbus 1023* (RSA).
34. *Bouteloua scorpioides* Lagasca. Coahuila: Km 162 carretera Matehuala - Saltillo, 18 XII 94, *Herrera & Cortés 1452* (CIIDIR-HUAA).
35. *Bouteloua simplex* Lagasca. Aguascalientes: 5 km al N del poblado Gracias a Dios, Jesús María, 2050 m, 14 XI 94, *Herrera y col. 1302* (CIIDIR-HUAA); Universidad Autónoma de Aguascalientes, 1880, Octubre 95, *Rosales s/n* (HUAA).
36. *Bouteloua triaena* (Trin.) Scribner. Querétaro: Alrededores de Macún, mpio. Cadereyta de Montes, 1800 m, 10 XI 88, *J. Rzedowski 47645* (IEB,CIIDIR).
37. *Bouteloua trifida* Thurner *in* S. Watson. Coahuila: 2 km al N de Cañada Blanca, km 17 carr. 57 Saltillo - Monclova, 1800 m, 4 X 95, *Herrera y col. 1480* (CIIDIR-HUAA); 8 km al SE de Palau, camino a Barroteras, Múzquiz, 24 V 77, *J. Váldés 939* (IEB). Tamaulipas: Ejido el Sauz, mpio. Antiguo Morelos, 160 m, 18 VIII 81, *I. Carrazco 034* (IEB); Rancho San Alfonso, mpio. Soto la Marina, 400 m, *J.A. Barrientos 765* (IEB); Camino a San Nicolás, mpio. San Nicolás, 400 m, 4 IX 81, *J.A. Barrientos 085* (IEB).
38. *Bouteloua uniflora* Vasey var. *coahuilensis* Gould & Kapadia. Aguascalientes: 9 km al E de Tepezalá, por el camino a Asientos, mpio. Tepezalá, 2250 m, 16 XI 94, *Herrera y Rosales 1307* (CIIDIR-HUAA).
39. *Bouteloua uniflora* Vasey var. *uniflora*. Coahuila: Al pie de la sierra La Gavia, km 117 carr. 57 Saltillo- Monclova, 1650 m, 4 X 95, *Herrera y col. 1486* (CIIDIR-HUAA).
40. *Bouteloua warnockii* Gould & Kapadia. Coahuila: 5.5 km al NW de Nva. Delicias, Vertiente E de la sierra de las Delicias, 1230 m, 5 X 95, *Herrera y col. 1492* (CIIDIR-HUAA).
41. *Bouteloua williamsii* Swallen. Aguascalientes: Ladera N cerro del Picacho, mpio. Jesús María, 1980 m, 4 IX 81, *De la Cerda 1006* (HUAA).

CUADRO 2. Caracteres epidermicos para formar la matriz.

1.- Dimensión vertical de los cuerpos de sílice.
2.- Dimensión horizontal de los cuerpos de sílice.
3.- Profundidad de las sinuosidades de las células largas.
4.- Forma de las sinuosidades: 1) en forma de Ω, 2) en forma de U.
5.- Longitud de los micropelos: 1) de 0-10 μ, 2) de 11-20 μ.
6.- Posición de los micropelos: 1) en el centro de la zona intercostal, 2) en toda la zona costal, 3) exteriores a las bandas de estomas en la zona intercostal.
7.- Ganchos en la zona costal: 1) presencia, 2) ausencia.
8.- Ganchos presentes en todas las zonas costales e intercostales.
9.- Ganchos en algunas zonas costales.
10.- Arreglo de las células costales: 1) CS-CC; 2) CS-CC-CL; 3) CS-CL.
11.- Cantidad de micropelos observados por campo a 40×.

1) CS-CC-CS-CC 2) CS-CL
3) CS-CC-CS-CC 4) CS-CC-CCL

26 especies entran en el arreglo número uno, cinco especies en el segundo, cinco especies en el tercero, seis especies en el cuarto.

Los ganchos (o cerdas) costales, son una característica importante que nos puede ayudar a separar a las especies en grupos. De acuerdo a esta característica el género se separa en cuatro grupos principales:

Grupo 1.- especies que presentan ganchos en todas las zonas costales de la hoja pudiendo encontrarlos en los extremos de la zona o esparcidos en diferentes filas de la zona costal. *Bouteloua curtipendula* var. *caespitosa*, *B. curtipendula* var. *curtipendula*, *B. curtipendula* var. *tenuis*, *B. disticha*, *B. elata*, *B. media*, *B. pedicellata*, *B. uniflora* var. *coahuilensis*, *B. uniflora* var. *uniflora*, *B. warnockii*, y *B. eriostachya*. Estas especies también presentan ganchos muy pequeños en la zona intercostal, semejantes a una uña, además de presentar micropelos en toda la zona intercostal. Estos emergen de la célula corta en ángulo recto en vista superficial, a excepción de *B. eriostachya* que presenta los micropelos en el área central entre las bandas de estomas (Figura 1).

Grupo 2.- Especies que presentan ganchos en algunas zonas costales de la hoja. *Bouteloua alamosana*, *B. aristidoides* var. *aristidoides*, *B. barbata* var. *barbata*, *B. barbata* var. *rothrockii*, *B. barbata* var. *sonorae*, *B. parryi* var. *parryi*, y *B. trifida* (Figura 2).

Grupo 3.- Especies en las cuales no se localizaron ganchos. *Bouteloua americana*, *B. chasei*, *B. chondrosioides*, *B. breviseta*, *B. eludens*, *B. eriopoda*, *B. gracilis*, *B. hirsuta* var. *glandulosa*, *B. hirsuta* var. *hirsuta*, *B. johnstonii*, *B. karwinskii*, *B. radicosa*, *B. repens*, *B. rigidiseta*, *B. scorpioides*, *B. simplex*, y *B. williamsii*. (Figura 3).

Grupo 4.- *Bouteloua chondrosioides, B. eludens, B. hirsuta* var. *glandulosa, B. hirsuta* var. *hirsuta, B. quiriegoensis,* y *B. repens*, presentan las 3ª y 4ª zonas costales de ambos extremos de la hoja con mayor número de hileras de células por cada zona, las células largas que se combinan con las células cortas son de tamaño pequeño muy semejantes a las células de corcho, con paredes gruesas, sinuosas, al igual que las células de corcho que las acompañan; los cuerpos de sílice son de dimensiones mayores que los presentados en las demás zonas; estas últimas zonas presentan 2 a 3 hileras de células por zona, las células largas son de mayor tamaño y los pares de células cortas son muy pequeños (Figura 4).

Todas las especies presentan ganchos angulares en los márgenes de las hojas, estos son diferentes a los ganchos costales pudiendo ser de diferente tamaño.

<u>En la Zona Intercostal encontramos que</u>:

Se presentan células largas con paredes horizontales paralelas unas con respecto a otras, rectangulares, con los márgenes sinuosos; células cortas en pares o solitarias, cuando son solitarias son células de corcho, las células cortas son altas y angostas en sentido vertical con los márgenes crenados o lisos. Los estomas se presentan un patrón definido de dos hileras o bandas horizontales en las todas las zonas costales, una hilera de estomas en las zonas intercostales de los extremos adyacentes a los márgenes de la hoja. Las especies mencionadas anteriormente que presentan la 3ª y 4ª zona costal con mayor número de filas de células, las zonas intercostales entre éstas pueden presentar una o dos hileras de estomas sin filas horizontales logitudinales entre las hileras de estomas.

Bouteloua chasei, B. johnstonii, y *B. scorpioides* presentan una solo hilera de estomas por cada zona intercostal, además de presentar las células cortas en pares muy semejantes en ambas zonas. *Bouteloua scorpioides* es un caso especial, presenta en toda la lámina células largas y células cortas muy parecidas, las zonas intercostales sólo se distinguen por las hileras de estomas además la característica particular de esta especie es que presenta zonas intercostales donde solo se localizan micropelos, no hay estomas característicos de dichas zonas, para diferenciar entre zona costal e intercostal se tuvieron que hacer tinciones con dos colorantes (verde rápido ademas de la safranina), con el fin de definir mejor las zonas y así poder describir mejor la especie.

Los micropelos son característicamente bicelulares en todas las especies, como ocurre en la Chloridoideas, difiriendo en tamaño cada célula, la célula distal presenta pared más delgada que la célula basal, su ápice es cónico a redondeado, mientras que la célula basal presenta su base en forma de cono invertido. Emergen de la célula corta, formando un ángulo recto o sin formar dicho ángulo, esto depende de la especie. Se localizan en el área central de la zona intercosta o en toda la superficie, estos arreglos también son importantes para la separación de las especies en grupos.

CUADRO 3. Matriz de caracteres epidermicos.

TAXA	CARACTERES										
	1	2	3	4	5	6	7	8	9	10	11
1	5	4	2	1	1	2	1	0	0	1	1
2	4	3	1	1	1	2	2	0	0	3	1
3	5	4	2	1	2	1	2	0	0	3	1
4	6	4	2	1	2	1	2	0	1	3	1
5	5	6	1	1	2	1	2	0	1	1	1
6	4	4	1	1	2	1	2	0	1	1	2
7	4	4	1	1	2	1	2	0	1	1	1
8	5	4	1	1	2	1	2	0	0	1	1
9	5	3	2	1	1	2	2	0	0	2	1
10	4	2	2	1	2	1	2	0	0	2	1
11	5	4	2	1	2	2	1	1	0	3	1
12	5	5	2	1	2	2	1	1	0	3	1
13	5	5	2	1	2	2	1	1	0	3	1
14	4	5	2	1	1	2	1	1	0	1	1
15	4	4	2	1	1	2	1	1	0	3	3
16	4	4	1	1	1	1	1	1	0	1	2
17	5	4	2	1	2	1	2	0	0	2	1
18	4	4	2	1	1	1	2	0	0	1	1
19	5	6	1	2	1	1	1	0	1	1	1
20	5	4	2	1	1	1	2	0	0	1	2
21	5	3	2	1	1	1	2	0	0	2	1
22	4	3	2	1	2	1	2	0	0	2	2
23	5	4	2	1	2	2	2	0	0	2	1
24	7	6	2	1	1	1	2	0	0	1	1
25	4	4	1	1	1	2	1	0	0	1	1
26	4	4	1	1	2	1	2	0	0	1	1
27	4	4	1	1	2	1	2	0	1	1	1
28	4	4	1	1	1	2	1	1	0	1	2
29	2	3	1	1	2	1	2	0	0	3	2
30	6	5	1	1	2	2	1	1	0	1	1
31	2	2	1	1	2	2	1	1	0	1	1
32	5	4	1	1	2	1	2	0	0	1	1
33	6	4	1	1	2	1	2	0	0	1	1
34	6	2	2	1	2	2	2	0	0	2	1
35	4	4	1	1	2	1	2	0	0	1	1
36	5	5	1	1	1	2	1	1	0	3	1
37	5	5	1	1	2	2	1	1	1	1	1
38	5	5	1	1	2	2	1	1	0	3	1
39	5	4	1	1	2	2	1	1	0	3	1
40	4	4	2	1	2	2	1	1	0	3	1
41	5	4	2	1	2	1	2	1	0	1	1

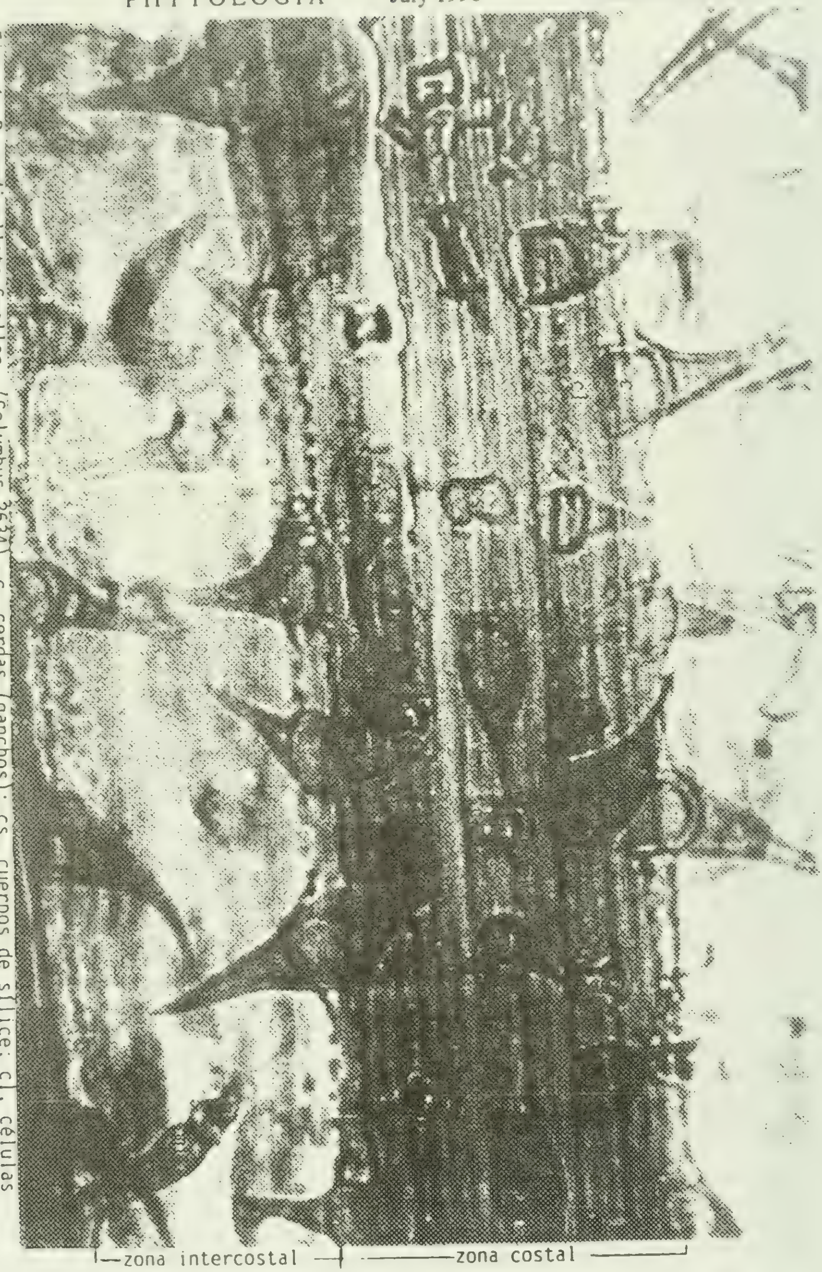


Fig. 1. *B. pedicellata* Swallen. (Columbus 2634). c, cerdas (ganchos); cs, cuerpos de sílice; cl, células largas; mi, micropelos. 400X.

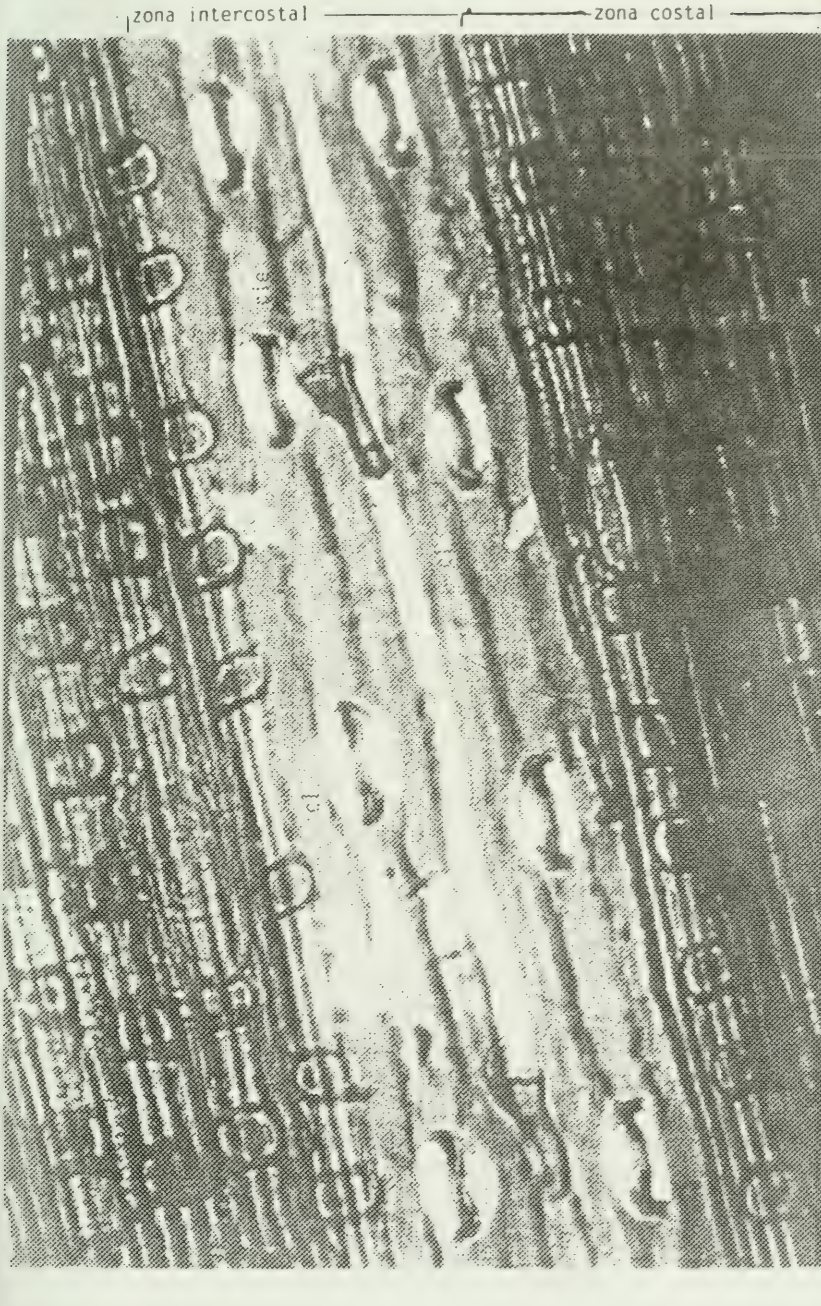


Fig. 2. B. parryi var. parryi (Spreng) Griffiths. (Peña 10100). c, cerdas; cc, células de corcho; cie, células interestomatales; cl, células largas; cs, cuerpos de sílice; e, estomas; mi, micropelos. 400X.

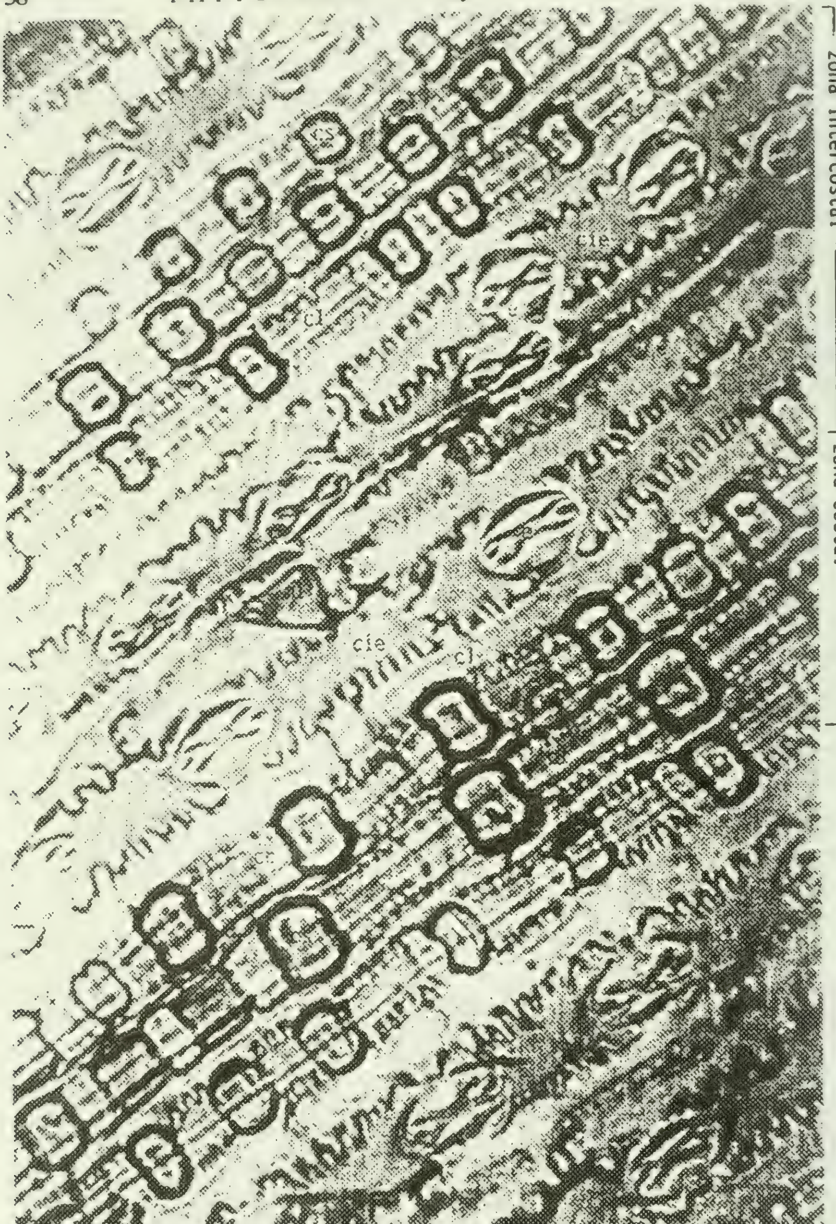


Fig. 3. B. breviseta Vasey. (Herrera et al 1479). cc, células de corcho; cie, células interestomatales; cl, células largas; cs, cuerpos de sílice; e, estomas; mi, micropelos. 400X.

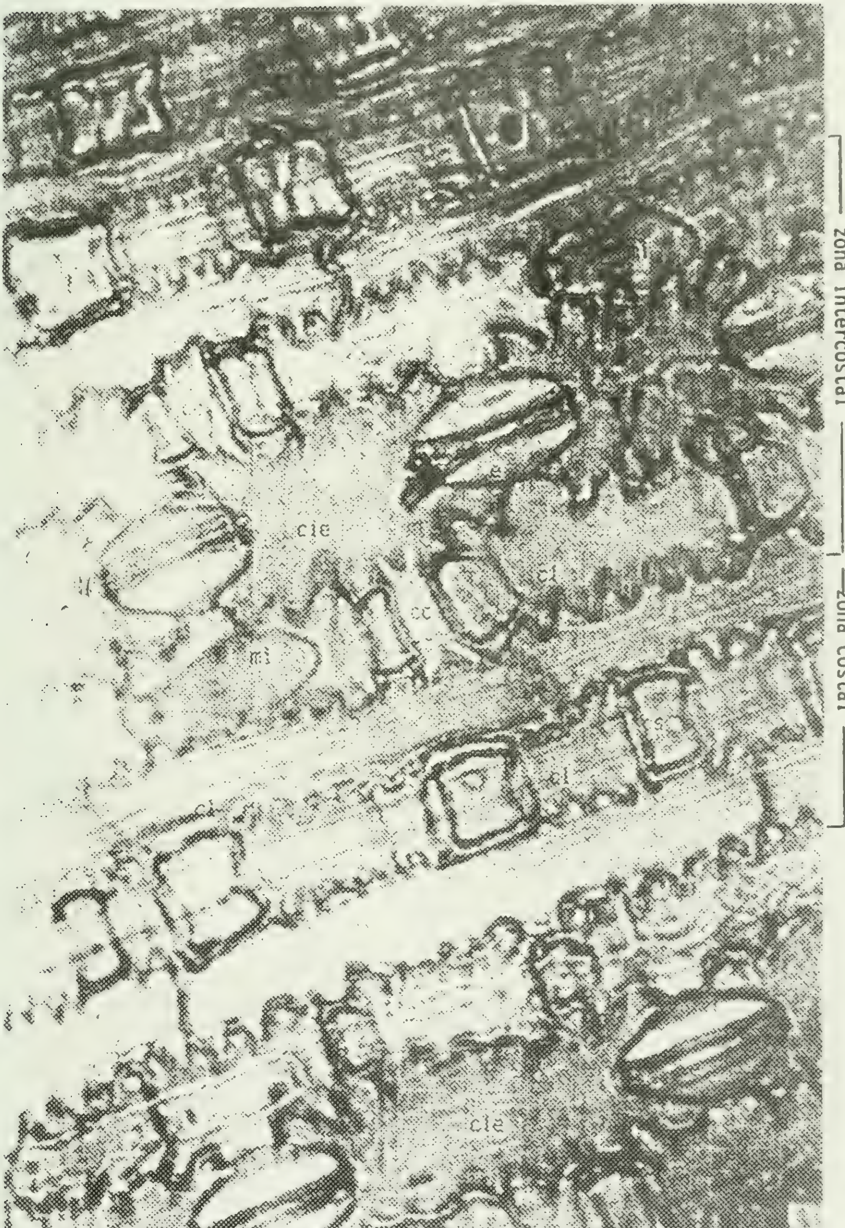
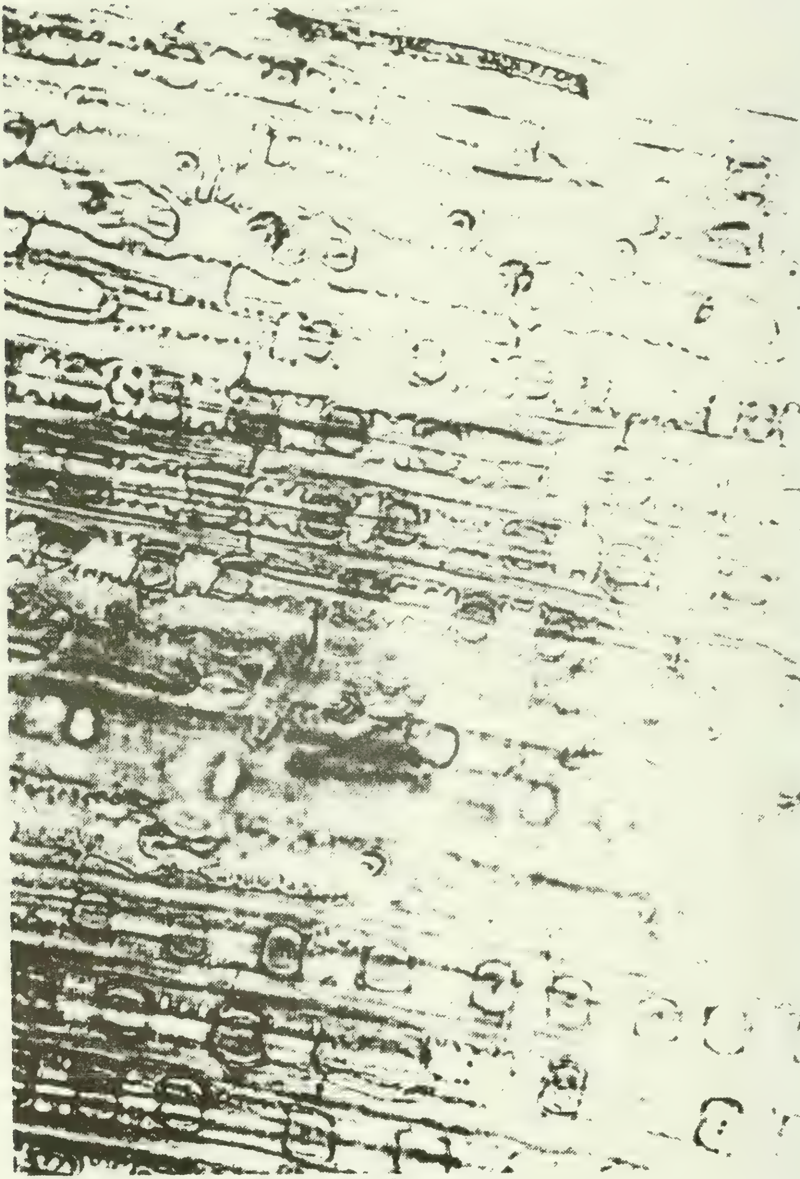
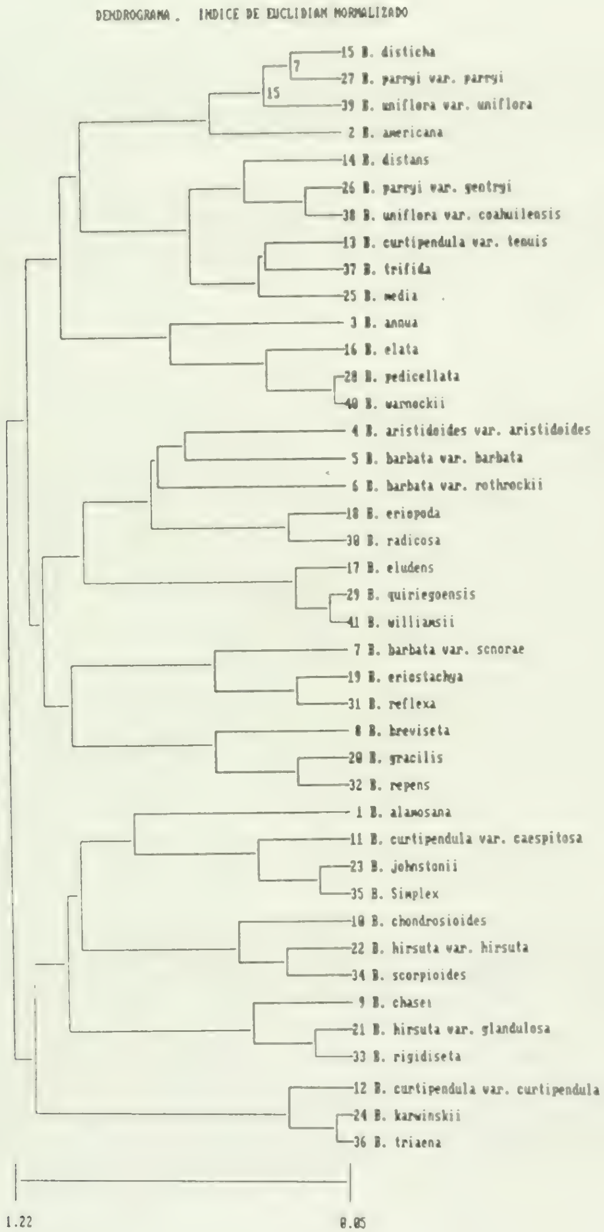


Fig. 4. B. hirsuta Lagasca var. hirsuta (De la Cerda 404). cc, células de corcho; cie, células interestomatales; cl, células largas; cs, cuerpos de sílice; e, estomas; mi, micropelos. 400X.



Bouteloua trifida Thurber in S. Watson 400X


DENDROGRAMA. INDICE DE EUCLIDIAN NORMALIZADO
7
15
15 B. disticha
27 B. parryi var. parryi
39 B. uniflora var. uniflora
2 B. americana
14 B. distans
26 B. parryi var. gentryi
38 B. uniflora var. coahuilensis
13 B. curtipendula var. tenuis
37 B. trifida
25 B. media
3 B. annua
16 B. elata
28 B. pedicellata
40 B. warnockii
4 B. aristidoides var. aristidoides
5 B. barbata var. barbata
6 B. barbata var. rothrockii
18 B. eriopoda
30 B. radicosa
17 B. eludens
29 B. quiriegoensis
41 B. williamsii
7 B. barbata var. sonorae
19 B. eriostachya
31 B. reflexa
8 B. breviseta
20 B. gracilis
32 B. repens
1 B. alamosana
11 B. curtipendula var. caespitosa
23 B. johnstonii
35 B. Simplex
10 B. chondrosioides
22 B. hirsuta var. hirsuta
34 B. scorpioides
9 B. chasei
21 B. hirsuta var. glandulosa
33 B. rigidiseta
12 B. curtipendula var. curtipendula
24 B. karwinskii
36 B. triaena
1.22
0.05

Las especies y variedades revisadas tienen características comunes como son: presentar células alargadas paralelas horizontalmente, sinuosas; células cortas en pares (la mayoría); estomas en forma de domo bajo, rectangulares y en hileras definidas en todas las zonas intercostales; micropelos bicelulares, cuerpos de sílice en forma de silla de montar formando una doble equis.

Es conveniente explicar que las aseveraciones anteriores respecto a los ganchos son de acuerdo a la parte de donde se hizo el corte, ya que pueden existir variaciones en la misma hoja o en hojas diferentes de la misma planta, también dependiendo de la maduréz de éstas.

DISCUSION

Para llevar a cabo el análisis fenético se tomaron once caracteres (Cuadro 2), de las 34 especies y doce variedades mexicanas del género *Bouteloua*. Con ellos se generó una matriz (Cuadro 3), con la cual se corrio un dendrograma, en el se observa como se van uniendo las especies por medio de nudos de acuerdo a las semejanzas que hay entre ellas y separando a las especies que comparten menos características. En el índice de similitud Euclidiana Normalizada se agrupan las especies en tres grupos bien definidos. En el grupo I se incluyen las siguientes especies: *B. uniflora* var. *coahuilensis*, *B. parryi* var. *gentryi*, *B. distans*, *B. americana*, *B. warnockii*, *B. trifida*, *B. media*, *B. curtipendula* var. *tenuis*, *B. parryi* var. *parryi*, *B. uniflora* var. *uniflora*, *B. disticha* *B. pedicellata*, *B. elata*, y *B. annua*. El grupo II lo forman: *B. quiriegoensis*, *B. eludens*, *B. aristidoides* var. *aristidoides*, *B. barbata* var. *barbata*, *B. eriopoda*, *B. radicosa*, *B. barbata* var. *rothrockii*, *B. williamsii*, *B. barbata* var. *sonorae*, *B. eriostachya*, *B. reflexa*, *B. breviseta*, *B. gracilis*, y *B. repens*. Mientras que el grupo III está integrado por: *B. hirsuta* var. *glandulosa*, *B. rigidiseta*, *B. chasei*, *B. alamosana*, *B. hirsuta* var. *hirsuta*, *B. scorpioides*, *B. chondosioides*, *B. curtipendula* var. *caespitosa*, *B. johnstonii*, *B. simplex*, *B. curtipendula* var. *curtipendula*, *B. triaena*, y *B. karwinskii*.

Como puede verse el dendrograma resultante, en el análisis agrupa en general las mismas especies, con algunas diferencias irrelevantes.

El dendrograma realizado en este trabajo muestra por un lado que todas las especies comparten caracteres comunes entre ellas como son, la forma de los cuerpos de sílice, las ondulaciones en las paredes horizontales de las células largas con sinuosidades en forma de Ω, los micropelos bicelulares, forma de los estomas, etc.

Se encontraron diferentes patrones en el arreglo y número de las hileras de células cortas-células largas en la zona costal: 1) zona costal del centro más ancha que el resto, 2) tercera y cuarta zona costal de ambos extremos de la lamina más ancha que las demás, 3) intercalándose zonas costales anchas y angostas, y 4) zonas costales homogéneas en toda la lámina.

CONCLUSIONES

De acuerdo con Metcalfe (1960) los caracteres anatómicos de la lámina de la hoja son significativos para la separación de especies, de géneros o de taxas mayores de plantas.

Con los resultados obtenidos en el presente trabajo, se puede concluir por un lado que las especies se delimitan perfectamente con base en sus caracteres anatómicos de epidermis, ejemplo de ello es el caso de *Bouteloua ramosa* que no presentó diferencias significativas con *B. breviseta*, de la cual parece ser sinónimo. Por otra parte el análisis fenético justifica la separación de algunas especies en variedades ya que al observar los grupos del dendrograma estas variedades quedan alejadas entre si ya sea en el mismo grupo o en grupos diferentes.

Por otra parte, existen discrepancias en la validéz del nivel genérico de *Bouteloua*, como una unidad, o si debe ser separado en dos géneros (*Bouteloua* Lag. y *Chondrosum* Desv.) como lo proponen algunos autores: Clayton & Renvoize (1986); Davidse, Sousa, & Chater (1994). Mientras que autores como: Gould (1979); McVaugh (1983); y Beetle, *et al.* (1987), consideran subgéneros a *Chondrosum* y *Bouteloua;* incluyendo en el primer subgénero a las especies conocidas comúnmente como Navajitas y en el segundo subgénero a todas las especies conocidas comúnmente como Banderillas. Con base en caracteres anatómicos de la epidermis, en el presente trabajo se llega a la conclusión de apoyar la delimitación de un solo género, por los patrones comunes que presentan todas las especies. Sin embargo se debe esperar a conjuntar los resultados de los diferentes caracteres que se estudian del género *Bouteloua*, para llegar a una conclusión mejor fundamentada.

En el dendrograma resultante del análisis fenético de este estudio, las especies se agrupan de forma diferente a como se agrupan tomando en cuenta los caracteres morfológicos unicamente (Herrera & De la Cerda 1997), de donde se percibe que los grupos de caracteres morfológicos y anatómicos no se comportan por igual entre las especies, concluyendose que posiblemente la evolución anatómica de la epidermis, durante la especiación del género *Bouteloua*, no siguió los mismos causes que la morfológica. Puesto de otra manera, puede interpretarse como que los cambios anatómicos de la epidermis no fueron influenciados por los mismos factores ecofisiográficos que defienieron las diferentes especies y variedades.

La homogeneidad en los caracteres anatómicos de la epidermis y los grupos de especies formados en el dendrograma muestra que éstos pudieron evolucionar por separado de los caracteres morfológicos, ya que los grupos no se forman solamente de especies conocidas comúnmente como banderilla o como navajitas de acuerdo a la forma de la inflorescencia, estos dos grupos se mezclan entre ellos debido a las características anatómicas comunes.

Como conclusión adicional es importante señalar que los estudios de la anatomía de la epidermis son importantes a nivel genérico, ya que pueden ayudar a reconocer fácilmente diferentes géneros de gramíneas cuando no se cuente con estructuras morfológicas suficientes para la determinación de tales grupos.

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INDEX TO AUTHORS, VOLUME 80

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